TEXAS OPTIMIZATION PROGRAM (TOP)
DIRECTED ASSISTANCE MODULE (DAM) 11

HOW TO PERFORM A RTCR (REVISED TOTAL COLIFORM RULE) LEVEL 1 ASSESSMENT (L1A)

STUDENT GUIDE

Latest Revision Date: August 27, 2019

Notes

Definitions

This is not an exhaustive list of definitions, but includes some that are used in the context of Level 1 Assessments.

Backflow event—Any of the ways that contamination can enter potable water, including cross-connection, backflow, backsiphonage, intrusion, or any other manner.

Calculated flush time (CFT)—The amount of time it takes water to get from the main to the sample tap

Cross-Connection Control Program (CCCP)—An overarching program to prevent contamination from cross-connections, backflow, backsiphonage, intrusion, etc. The CCCP includes a plumbing ordinance and/or service agreements, a backflow prevention device testing program, Customer Service Inspections, and cooperation between all parties responsible for portions of the program.

Dead-end main (DEM) flushing—TCEQ-requires monthly flushing at all dead-ends regardless of size or type of flush valve.

False positive—This term is used to describe a situation where the TC+ is not representative of drinking water quality in the distribution system. For example, when stagnant water from a sample line is analyzed, so a TC+ represents sample-line water, not water from the main pipes.

Hydraulic dead end—A location where water stagnates, but not because of a physical dead-end.

Public water system (PWS)—An entity that provides water for human consumption to at least 25 people at least 60 days a year (see §290.38)

Sanitary defect—A potential pathway for pathogens to enter drinking water.

Unidirectional flushing (UDF)—A method of isolating and flushing small areas with a velocity of 5 feet-per-second (fps) or more to remove sediment and biofilm.

Acronyms and abbreviations

This is not an exhaustive list of acronyms and abbreviations, but includes a variety that are used in the context of Level 1 Assessments.

BPAT Backflow prevention assembly test or tester

CARP Corrective Action Report and Plan

CCCP Cross-Connection Control Program

CFT Calculated flush time

DAM Directed Assistance Module

DCP Drought Contingency Plan

DI Deionized

DWW Drinking Water Watch (dww2.tceq.texas.gov/DWW/)

EC+ *Escherichia coliform* (*E. coli*) found

FAA Free available ammonia

FAC Free available chlorine

fps Feet-per-second

Mono Monochloramine

NAP Nitrification action plan or a short period of sleep

PWS Public water system

RTCR Revised Total Coliform Rule (2016)

SOP Standard operating procedure

SWP Source Water Protection program

TAC Texas Administrative Code or total available chlorine

TC+ Total coliform found

TCEQ Texas Commission on Environmental Quality

TCR Total Coliform Rule (1986)

TMI Too much information

TOP Texas Optimization Program

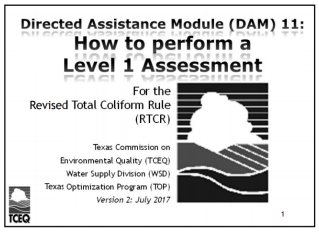
TSMP Triggered-Source Monitoring Plan

Table of Contents

DAM 11
How to Perform a Level 1 Assessment (L1A) Under the Revised Total Coliform Rule (RTCR)

***Disclaimer**: This Directed Assistance Module (DAM) describes the regulatory requirements of Title 30, Texas Administrative Code (30 TAC) Chapter 290, relating to public water systems (PWSs). Should there be any inadvertent discrepancy between this training and the rules of 30 TAC Chapter 290, the rules shall apply.*

Introduction



A Level 1 Assessment is a way to 'find and fix' problems that may have led to the presence of total coliform at public water systems (PWSs). These problems are called sanitary defects—defined as ***"a potential pathway for pathogens."***

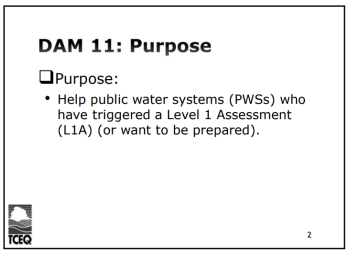
Starting April 30, 2016, the Level 1 Assessment replaces the non-acute violation of the previous Total Coliform Rule (TCR).

A Level 1 Assessment includes:

- Reviewing data, for example:
  - Coliform, disinfection, and flushing data;
- Reviewing documents, for example:
  - Regulatory reports and correspondence,
  - Standard operating procedures (SOPs), and
  - Monitoring plan;
- Performing on-site assessments, for example:
  - Total coliform positive (TC+) sites and nearby areas,
  - Tanks, and
  - Sources;
- Assessing sources, treatment, distribution facilities, and operation to determine whether sanitary defects were found;
- Completing the TCEQ Level 1 Assessment form;
- Listing sanitary defects, additional issues, and corrective actions in the Corrective Action Report and Plan; and
- Submitting the Level 1 Assessment form and (at least) the two required attachments to the TCEQ within 30 days of the date that the trigger occurred.

Prior to the Revised Total Coliform Rule (RTCR), those situations would have required a PWS to notify their customers of a 'non-acute violation.' Now, the Level 1 Assessment replaces that violation. A PWS is now only in violation if they fail to complete the Level 1 Assessment on time.

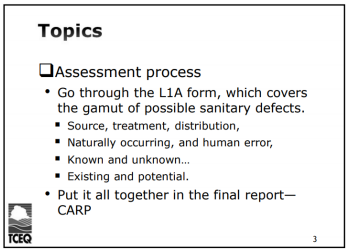
Purpose



The TCEQ has designed the Level 1 Assessment form to guide the Assessor through the process of doing the assessment. The instructor will provide current copies of the Level 1 Assessment form during this DAM.

The Level 1 Assessment form is available on the web at:

www.tceq.texas.gov/drinkingwater/microbial/revised-total-coliform-rule



The Level 1 Assessment process is essentially a shorter version of the Comprehensive Compliance Investigation that TCEQ regional investigators perform every three years for community PWSs and every five years at non-community PWSs. Most items listed in the Level 1 Assessment form are related to the rules and regulations for PWSs contained in Title 30, Texas Administrative Code (30 TAC) Chapter 290, Subchapter D. That means that some sanitary defects may have been found and documented in TCEQ investigation reports. PWSs and assessors can find the contact information for their local TCEQ region at:

www.tceq.texas.gov/about/directory/region/reglist.html

NOTE: If Escherichia coli (E. coli) is found in addition to total coliform, a PWS may be required to do a Level 2 Assessment, which is more in-depth.

When is a Level 1 Assessment required?

A PWS must do a Level 1 Assessment if:

- A PWS collecting fewer than 40 samples per month has two (2) or more TC+ in a month—routine and/or repeat.
- A PWS collecting at least 40 samples per month has over 5.0 % of routine/repeat samples TC+ in a month.
- A PWS fails to take **every** required repeat sample after any single TC+ sample.

Note that if a PWS triggers a Level 1 Assessment a second time in 12 months, a Level 2 Assessment must be performed by a third-party approved by the TCEQ.

What reporting is required?

Within 30 days after a PWS triggers a Level 1 Assessment, the PWS must:

- Perform a Level 1 Assessment;
- Complete and submit the Level 1 Assessment form to the TCEQ; and
- Report on any sanitary defects and corrections.

The 30-day window starts on the date that data was collected that confirmed the trigger occurred

Getting started

Prerequisites for this DAM

This DAM is intended for people who have some familiarity with operation or management of a PWS. For example: the chief operator at a city, a utility manager, or an owner of a campground. It will also benefit engineers, operators, and other people who help PWSs. A person does not need to be a licensed water operator to benefit from this training.

Additional training is available through the TCEQ's FMT Assistance Program at 512-239-4691. For example, staff at systems that use chloramines can request DAMs on chloramination and Nitrification Action Plans. In the summer of 2016, a DAM on putting together a successful Cross-Connection Control Program will become available.

Participating in this DAM is not the same as performing a Level 1 Assessment

The training in this DAM should allow an owner, manager, or operator to learn how to perform the Level 1 Assessment. It remains the PWS's responsibility to ensure that someone completes the Level 1 Assessment.

No single training event can create an expert. The assessor should be ready to seek expert assistance on items outside their expertise.

This DAM may be provided when a PWS has triggered a Level 1 Assessment. After participating in this DAM, a well-prepared PWS may have to do a few additional hours of work to complete a required Level 1 Assessment form for submittal to the TCEQ. A less well-prepared PWS may have to do more additional work to complete their Level 1 Assessment and submit the form. A PWS may request additional TCEQ Financial, Managerial, and Technical (FMT) assistance for action items identified through this DAM. To request the free, on-site assistance, call the TCEQ Water Supply Division at 512-239-4691.

Logistics

This training is a primarily a desk-top exercise. The classroom portion of the training should be held in a room or office that is clean, dry, and not too noisy.

If performed in a small system, there may be time for on-site assessment of a sample site, tank, or source.

Instructors for this workshop are subject-matter-experts approved through the TCEQ's Occupational Licensing process described in Regulatory Guidance (RG) 373. For any questions about the instructor approval process, contact the TCEQ at 512-239-1000.

DAM schedule

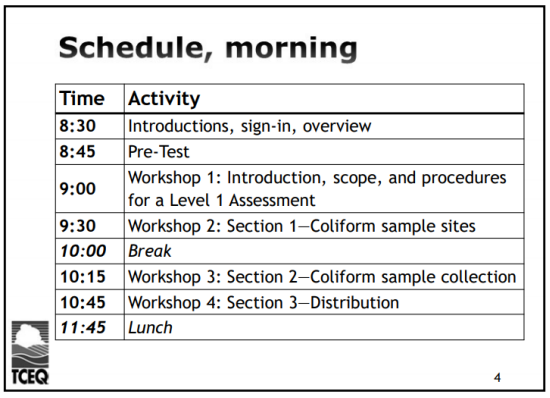
Today's training has an ambitious schedule. Please work with the instructor to stay on time. The schedule is shown below.

Agenda for DAM11-RTCR Level 1 Assessment

Time	Activity
8:30-8:45	Introductions, sign-in, overview—15 minutes
8:45-9:00	Pre-Test—15 minutes
9:00-9:30	**Introduction, scope, and procedures for performing a Level 1 Assessment** (30 minutes)
9:30-10:00	**Workshop 2:** Section **1—Coliform sample sites** (30 minutes)
10:00-10:15	*Break*
10:15-10:45	**Workshop 3:** Section **2—Coliform sample collection** (30 minutes)
10:45-11:45	**Workshop 4:** Section **3—Distribution** (60 minutes)
11:45-12:45	*Lunch*
12:45-1:15	**Workshop 5:** Section **4—Tanks** (30 minutes)
1:15-1:45	**Workshop 6:** Section **5—Treatment** (30 minutes)
1:45-2:00	*Break*
2:00-2:30	**Workshop 7:** Section **6— Sources** (30 minutes)
2:30-2:45	**Workshop 8:** Section **7 & 8—Security, weather, and PWS compliance status** (15 minutes)
2:45-3:30	**Workshop 9:** Section **9, 10, & 11—Sanitary Defects, Corrective Action, and Additional Issues** (45 minutes)
3:30-3:50	Post-Test and review of answers—20 minutes
3:50-4:00	Evaluation—10 minutes

This DAM includes five hours of training; one hour testing and evaluation; and one-and-one-half hours of breaks and lunch.

Students will need to commit a full work day to participate in this DAM.



Schedule, morning

Time	Activity
8:30	Introductions, sign-in, overview
8:45	Pre-Test
9:00	Workshop 1: Introduction, scope, and procedures for a Level 1 Assessment
9:30	Workshop 2: Section 1—Coliform sample sites
10:00	*Break*
10:15	Workshop 3: Section 2—Coliform sample collection
10:45	Workshop 4: Section 3—Distribution
11:45	*Lunch*

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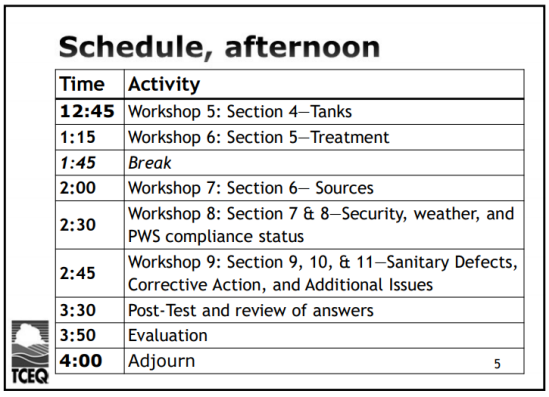

Schedule, afternoon

Time	Activity
12:45	Workshop 5: Section 4—Tanks
1:15	Workshop 6: Section 5—Treatment
1:45	*Break*
2:00	Workshop 7: Section 6— Sources
2:30	Workshop 8: Section 7 & 8—Security, weather, and PWS compliance status
2:45	Workshop 9: Section 9, 10, & 11—Sanitary Defects, Corrective Action, and Additional Issues
3:30	Post-Test and review of answers
3:50	Evaluation
4:00	Adjourn

TCEQ

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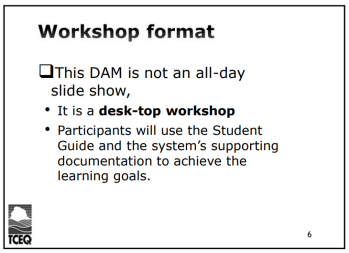
Training materials



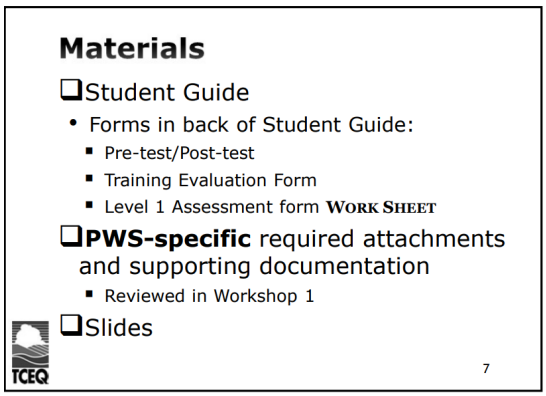
The instructor of this DAM will provide copies of the most current versions of this Student Guide. If this training is performed at a PWS, the system will also have to gather some supporting documentation, described above.

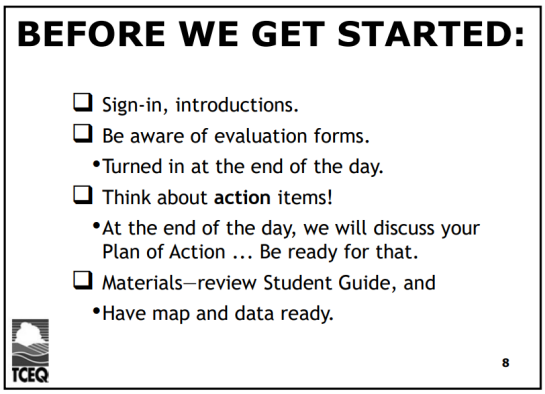
Material for the PWS to gather:

Especially for a PWS that is scheduling this DAM because they triggered a Level 1 Assessment, the PWS that is receiving training should gather as much of the information used for the assessment prior to the DAM event. This information includes:

- Coliform sample collection SOP,
- Disinfection level results,
- Latest CCI report,
- Regulatory correspondence,
- Microbial Report Forms,
- Monitoring plan, including,
    - Coliform Sample Siting Plan (SSP),
    - Distribution system map, and
    - Nitrification Action Plan (NAP) for chloramine systems,
- Flushing records.
- Distribution operation and maintenance records, for example:
    - Work orders, ,
    - Pressure and complaint data,
    - SOP for disinfection after repair and/or construction
- Chemical and water usage reports,
- Water loss records,
- Tank inspection reports,
- Cross-connection control program documents, and
- SWMORs for SWTPs.

The DAM will be most successful if this information is available.





Resources

Portions of this guidance reference the EPA's guidance manual—**"REVISED TOTAL COLIFORM RULE ASSESSMENTS AND CORRECTIVE ACTIONS GUIDANCE MANUAL (INTERIM FINAL)"** which is available at:

water.epa.gov/lawsregs/rulesregs/sdwa/tcr/upload/epa815r14006.pdf

The most current versions of the Level 1 Assessment form and instructions are on the TCEQ's web site at

www.tceq.texas.gov/drinkingwater/microbial/revised-total-coliform-rule

Student Guide reference

This DAM is intended to use the data for the PWS that it is being given at. Please try to have a way to share the distribution map with all the students. For example, make several copies.

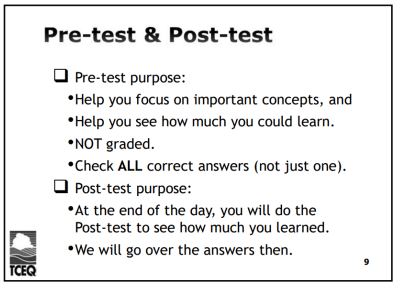
In order for your Student Guide to be useful as a reference, you need to become familiar with it. As you go through the workshops:

- Open the Student Guide to see what information is provided.
- Start completing the Level 1 Assessment **WORK SHEET** in Appendix 11.

Level 1 Assessment form **WORK SHEET**

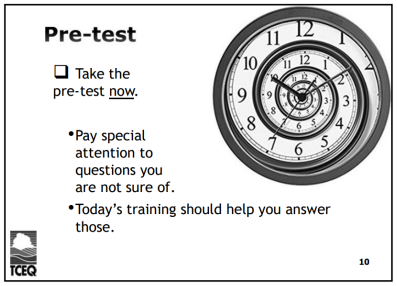
List follow-up items that you identify while going through the training on the Level 1 Assessment **WORK SHEET** at the back of this Student Guide (Appendix 11).

Pre- and Post-Test instructions



This DAM includes a Pre- and Post-Test intended to help the student's learning process. These tests will NOT be graded.

When you take the Pre-Test, note the questions that were puzzling—the answers will be covered in the course. If they are not—make sure to ask about them.



The questions in the test are intended to be related to important parts of the material covered. If you have suggestions to improve the test, please provide those ideas in your course evaluation.

Training Evaluation Form

A Training Evaluation Form is included in this Student Guide. Students will complete this evaluation and return it to the instructor who will collect those to route securely to the TCEQ's Water Supply Division, who developed this training. By submitting your input, the TCEQ can continue to improve the training we develop.

You may complete the Training Evaluation Form anonymously if you wish, but do note the date and location at the top of the form.

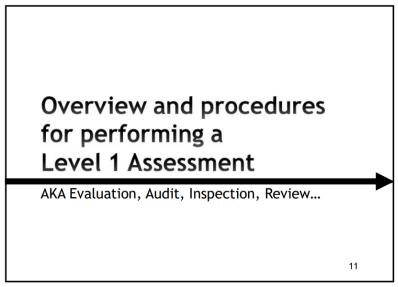
Follow-up

During the day, note actions that you should take to correct sanitary defects or complete the Level 1 Assessment.

If you have items of concern which you wish to communicate anonymously by phone, please contact the Texas Optimization Program (TOP) at 512-239-4691.

Notes

Overview and procedures for performing a Level 1 Assessment



Before getting into the details of the Level 1 Assessment, it is smart to plan and prepare to make the process as smooth as possible.

Scope

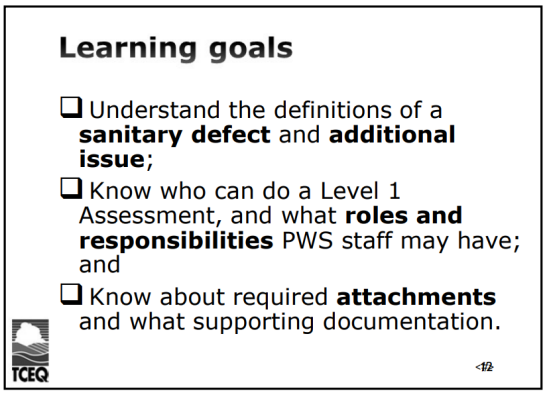
This section covers:

- An overview of the scope of a Level 1 Assessment—finding and fixing sanitary defects;
- Determining roles and responsibilities for the PWS and the assessor;
- Gathering the required attachments and supporting documentation that will be assessed; and
- The logistics of the Level 1 Assessment.

Learning goals

The learning goals for this workshop are:

- Understand the definitions of a sanitary defect and additional issue;
- Be aware of the questions in the Level 1 Assessment form (details will come later);
- Know who can perform a Level 1 Assessment, and what roles and responsibilities PWS staff may have; and
- Know required attachments must be submitted with the Level 1 Assessment and what supporting documentation may also be needed to perform the assessment.



Supporting documentation

For this section, the student should look at the materials provided for the course, particularly:

- ✓ The Student Guide,
- ✓ The Level 1 Assessment form, and
- ✓ The Level 1 Assessment form **WORK SHEET**.

Part 1. Overview of Level 1 Assessment

Overall, a Level 1 Assessment covers a broad range of considerations that can impact how well the PWS is able to keep pathogens out of the system, and be able to figure out if it did.

Scope

The scope includes:

- The definition and importance of **sanitary defects**;
- Understanding how **TC+ indicates** potential problems with **pathogens**;
- How pathogens could enter or grow in the drinking water, including:
  - **Source** water degradation or contamination,
  - **Treatment** failure or interruption,
  - Excessive **water age** or low **pressure**,
  - **Leaks or contamination** in distribution,
  - **Cross-connection** control and backflow/backsiphonage protection, and
  - **Security** and emergency response;
- How inaccurate data can lead to sanitary defects; and
- How to write Corrective Action Report and Plan (**CARP**) and additional issue report items.

This is a broad range of areas where a PWS could have sanitary defects, additional issues, or false positives.

Learning Goals

The learning goals for this overview are for the student to:

- Understand the general assessment process,
- Understand the definitions of a sanitary defect and additional issue;
- Know who can do a Level 1 Assessment, and what roles and responsibilities PWS staff may have; and
- Be able to gather the information needed to perform the Level 1 Assessment, and attach to the form when it is sent in.

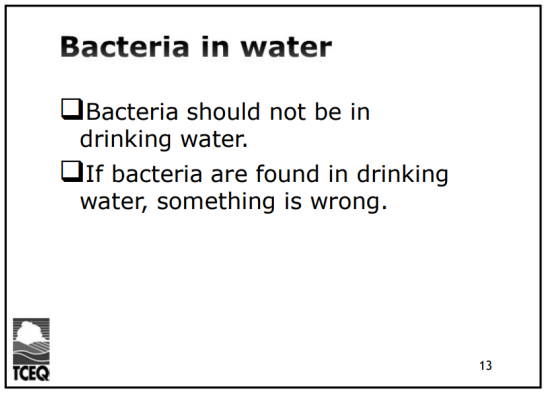
Materials

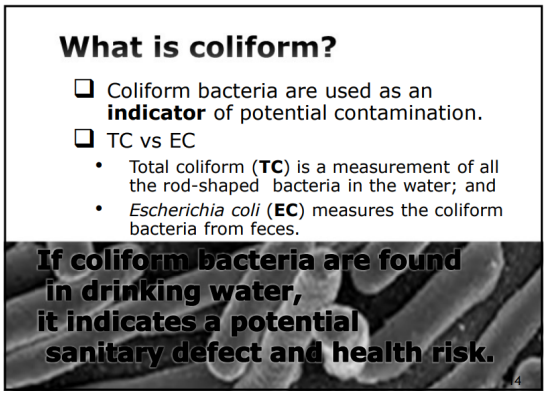
The resources to consult for this section include:

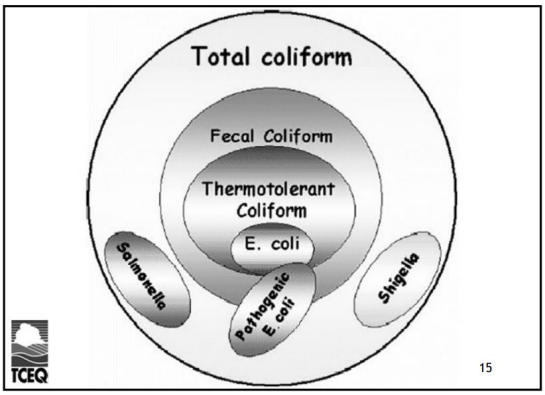
- The first page of the Level 1 Assessment form (or WorkSheet), and
- The Student Guide.

Part 2. Definitions of sanitary defects

Bacteria should not be in drinking water. If bacteria are found in drinking water, something is wrong.







The two main things that a Level 1 Assessment is looking for are:

- Sanitary defects, and
- Additional issues.

A third thing to be on the lookout for is:

- False positives.

Sanitary defect

Sanitary defects are potential pathways for pathogens.

A sanitary defect of some sort almost certainly led to there being coliform in the water. It is a less-than 1-in-100 chance that a false positive led to the presence of coliform.

The word '**potential'** in the definition means the assessor is not just looking for that single sanitary defect that led to TC+ in this case, but is also looking for other conditions that could cause TC+ in the future.

Generally, the questions on the form should help the assessor consider what might be a sanitary defect.

Additional issues

Even with the definition of sanitary defect including 'potential' pathogenic contamination, the assessor may find issues that don't seem to fit that definition. For example, there may be problems that could lead to bacteria in the water that are not related to any question on the Level 1 Assessment form.

These types of problem are called 'additional issues.'

When looking at Comprehensive Compliance Investigation reports from TCEQ, you may notice that in addition to violations, the investigator may list 'additional issues.' In that context, the additional issue would be something that the investigator saw that was not quite out of compliance but was fixin' to be.

False positives

A false positive is basically bad data. The term is used to describe any situation where the TC+ is not representative of drinking water quality in the distribution system.

The type of false positive that most people tend to think TC+ is caused by is incorrect sample collection. However, there is less than a 2% chance that a TC+ is caused by sampler error—even when they are doing a *bad* job. When the sampler does a *good* job, the chance is much less than that. This tendency to blame sample collection technique has led to the requirement for a sample collection SOP as discussed in Workshop 2.

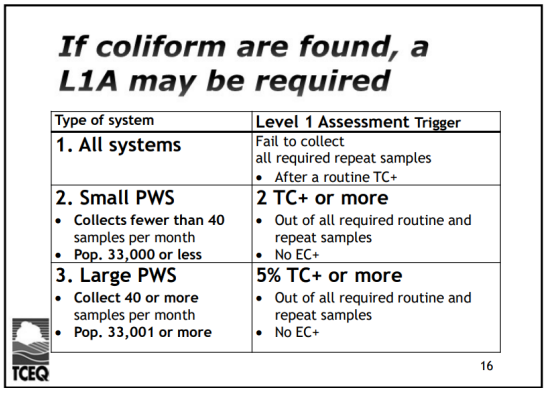
A better, and more common, example would be when stagnant water from a sample line is analyzed, so a TC+ represents sample-line water, not water from the main pipes.

False positives are bad because **bad data leads to bad decisions**. The operators will focus their time and energy on 'fixing' the area where the false positive occurred, even though that is not actually an at-risk area. This can cause them to miss an actual problem somewhere else.

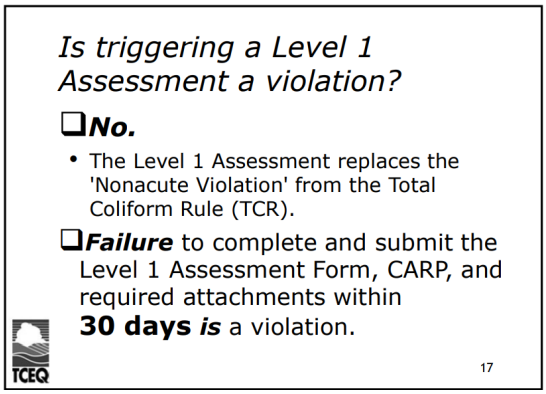
Part 3. Assessment process summary: overview

In order to assess coliform sample sites, the assessor will consider all sites where positive results. It is highly recommended that sites where samples were rejected also be assessed.

If coliform is found, a Level 1 Assessment may be required.



It is not a violation—but failing to do it is a violation.



In general, any assessment involves some basic steps:

- Plan and prepare,
- Review data,
- Review documents,
- Perform on-site observations,
- Document findings in the required format,
- Describe what actions will be taken in response to the findings,
- Communicate the findings and planned actions with those who need to know:
    - Regulators,
    - Managers,
    - Workers.

Assessment: In general

- ❑ Review documents and data
- ❑ Verify contents of documents in data
  - For example—on-site visit
- ❑ Compare data to standards
  - For example—is it sanitary?
- ❑ Document findings
  - (Corrective Action Report and Plan)

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Assessment: L1A

- ❑ **Analysis**
  - Reviewing **data**, for example:
    - Coliform, disinfection, and flushing data;
  - Reviewing **documents**, for example:
    - Regulatory reports and correspondence, Standard operating procedures (SOPs), and Monitoring plan;
  - Performing **on-site** assessments, for example:
    - Total coliform positive (TC+) sites and nearby areas, Tanks, and Sources;
  - Assessing **sources, treatment, distribution** facilities, and operation to find sanitary defects;
- ❑ **Synthesis** (and documentation)
  - Completing the TCEQ Level 1 Assessment form;
  - Listing sanitary defects, additional issues, and corrective actions in the Corrective Action Report and Plan; and
  - Submitting the Level 1 Assessment form and attachments to the TCEQ within 30 days of the trigger

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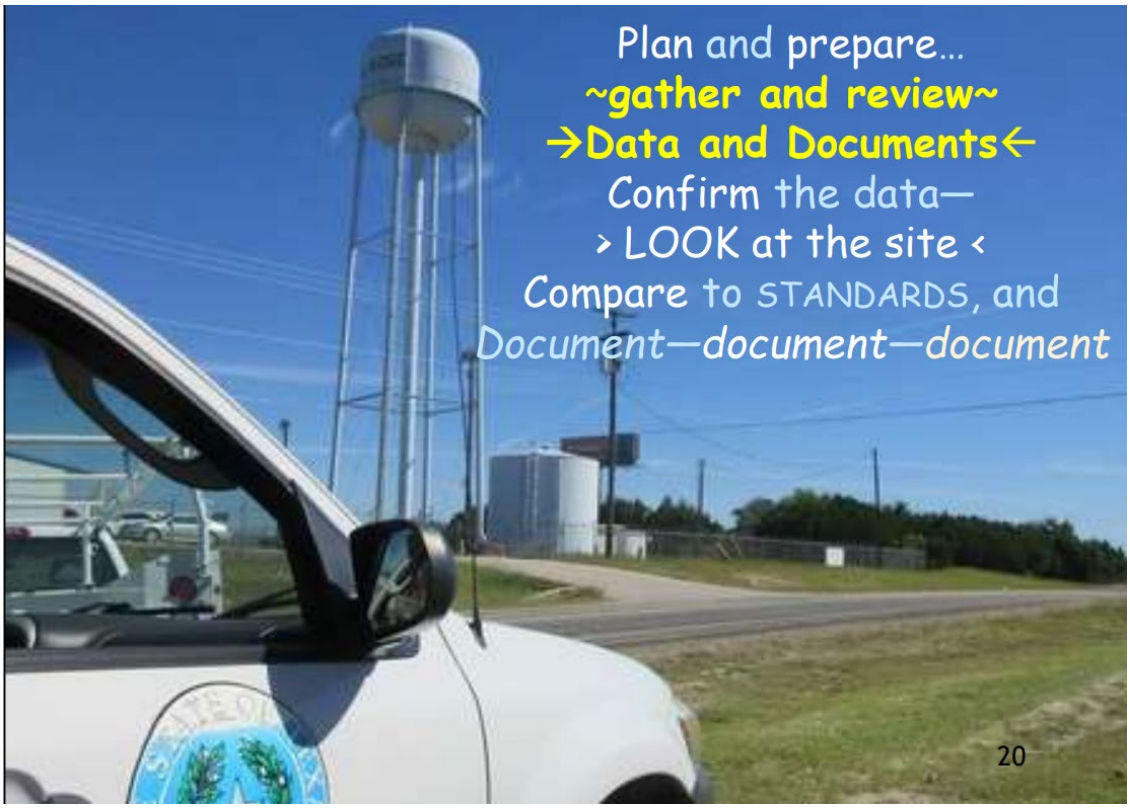


1. Plan and prepare

Planning and preparing includes:

- Determining roles and responsibilities, and
- Gathering data and documents.

Gathering data and documents, is a big part of the Level 1 Assessment.

It is highly recommended that the PWS consult with the TCEQ immediately upon realizing that a Level 1 Assessment has been triggered. It is not a rule requirement that the TCEQ notify PWSs of triggering the assessment. Instead, it is a PWS's inherent responsibility to know the rules and follow them. By consulting with the TCEQ, the PWS can:

- Be aware of when the Level 1 Assessment submittal is due;
- Get the most recent version of the Level 1 Assessment form; and
- Learn about free training opportunities.

On the first page of the Level 1 Assessment Work Sheet, you can see that the list of documents this DAM discusses is quite long. Especially for a larger system, it may be necessary to get more than one person working on this process.

Required attachments versus supporting documentation

The two required attachments are just what TCEQ wants to see.

However, in order to answer the questions on the Level 1 Assessment form, the assessor will need to look at the supporting documentation. It is not required to send all that paperwork to TCEQ. However, it is highly recommended that answers be based on actual data, documents, or on-site observations, rather than pulling an answer out of your back pocket.

2. Review data

The data often communicates clues to the issue. Data refers to numbers, not words--like operational information that changes over time, like pressure and disinfectant residual.

Each portion of the Level 1 Assessment will involve looking at different data—some more, some less.

Gather additional data if needed

In some cases, the assessor may feel the need to gather additional data, for example:

- Find out if a sample tap has a point-of-use device upstream;
- Chlorine residual data at TC+ sites and the surrounding area,
- Water quality parameters like pH, hardness, alkalinity, etc.,
- Pressure data at TC+ sites,
- Chemical usage,
- Flow rates,
- Etc.

3. Review documents

Documentation will illuminate issues like historical violations. Documentation refers to information that does not change rapidly—like system design. It is generally words, not numbers.

Examples of documentation include:

- TCEQ investigation reports;
- Regulatory correspondence from TCEQ, like notices of violation or enforcement;
- Tank inspection reports;
- Service Agreements, Customer Service Inspection reports, and Backflow Prevention Assembly Testing and Maintenance forms;
- Etc.

4. Perform on-site evaluations

Especially if the assessor is unfamiliar with the PWS, it is necessary for the assessor to physically observe some aspects of the system. If the assessor is the PWS operator, they are probably already familiar with the facilities and may not need to do a separate visit—but it may be a good idea for them to do one just to see if there is anything unusual going on.

It is a good idea for the assessor to take notes and photographs of their on-site evaluation to be able to share their information with others at the PWS or TCEQ.

The purpose of the on-site evaluations is to verify that what was written in data and documents describes reality. For example, if a tank inspection form says everything is okay, but a plane just flew into a storage tank, it is important for the assessor to see that with their own eyes.

5. Fill out the Level 1 Assessment form

The Level 1 Assessment form is a tool designed to make sure that the assessor considers a broad range of possible sanitary defects and does not just jump to conclusions. Going through the form should lead the assessor to identify sanitary defects that need to be corrected and reported on.

The completed form itself does not communicate the findings of the Level 1 Assessment. Instead, that job is done by the CARP and additional issues report.

6. Write up the Corrective Action Report and Plan and additional issues

The process of writing the CARP is basically:

Go through the completed Level 1 Assessment form and identify the things that need to be described in the CARP,

List those in the CARP, grouped by the corrective action that will fix them.

In the CARP, write a brief statement explaining:

- What the issue is, and
- How it was corrected, or

- Will be corrected.

7. Sign and submit the Level 1 Assessment forms and attachments

The assessor must be identified on the form. A representative of the PWS must sign the form.

The PWS remains responsible for ensuring that the Level 1 Assessment is completed correctly, regardless of who does the assessment or signs the form.

It is highly recommended that the Responsible Party of the PWS be made aware of any PWS regulatory action such as the Level 1 Assessment.

To learn where to send the submittal, contact your local regional TCEQ office or contact the Water Supply Division (WSD) at 521-239-4691.

Part 4. Roles and responsibilities

Who can do a Level 1 Assessment?

The first thing to figure out is who is going to do the Level 1 Assessment. If it is not someone that works for the PWS, the next thing is coordination between the assessor and the PWS.

On the Level 1 Assessment form, the PWS certifies that the information is true and correct. During an assessment, you should consider who will be the assessor, and who will sign the form on behalf of the PWS.

The TCEQ rules allow various people to do a Level 1 Assessment. As of January 31, 2018, the TCEQ has not yet required any specific training for assessors who perform Level 1 Assessments. People who are approved by TCEQ's rules to perform Level 1 Assessments include [290.109]:

- The public water system; or
- Licensed operators (at a level required for the system by §290.46(e)); or
- Licensed backflow prevention assembly testers (BPATs); or
- Licensed customer service inspectors (CSIs); or
- Licensed plumbing inspectors; or
- Licensed water supply protection specialists; or
- Licensed professional engineers (PEs); or
- Circuit riders or technical assistance providers under contract with the TCEQ or any other government agency; or
- Utility supervisor or manager supported by various utility staff or other individuals that meet the assessment requirements as described in this paragraph.

It is not expected that a PWS will have any difficulty identifying someone with one of the credentials listed above. Note, however, that the regulations do not explicitly allow any employee of the TCEQ to perform a Level 1 Assessment. A PWS should not be expecting the TCEQ to perform this task for them.

Whoever is identified as the assessor, they will need to work closely with the PWS to be successful. It will probably be helpful for them to interview an operator who is knowledgeable about the PWS operation, monitoring, and maintenance at the system. An assessment is easier if the assessor is familiar with the PWS and has some understanding of drinking water rules and practice.

- The assessor should be given access to all PWS representatives and paperwork.
- If the PWS has multiple licensed operators, the Level 1 Assessment may be best performed by the operator-in-responsible-charge, for example, the Utility Superintendent or Lead Operator.
- If a TNC PWS has multiple owners, operators, or managers, it may be best for the person with greatest responsibility and knowledge of the PWS activities to perform the assessment and complete the form, while coordinating with the other owners.

- In some cases, the Assessor may not be an expert in every aspect of PWS operation, and may not have any familiarity with the system. In that case, it may be helpful for the assessor to be able to **consult with experts** who are knowledgeable on those topics during the assessment. For example, a licensed plumbing inspector would not be expected to have any familiarity with TCEQ PWS rules, so that individual might want to seek assistance on that topic.

Discussion of key administrative activities

Leadership determines the direction of an organization. In the context of the Level 1 Assessment, the following leadership elements are factors:

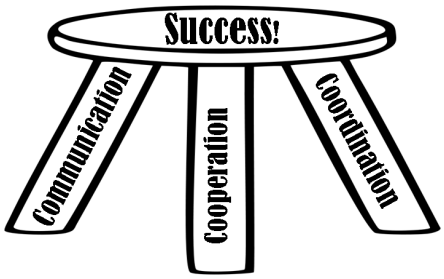
- Current data for the administrative contact;
- External communication with the TCEQ; and
- Internal communication between staff and managers, including goal-setting and SOPs.

It may be a greater challenge for a large system than a small system to ensure that the person who is the 'Captain of the Ship'—the Administrative Contact or responsible party—is aware of the assessment and is available to sign the completed form. Therefore, one of the first things a large system may need to do is for staff who are aware of the assessment to elevate the request for signature through the chain-of-command immediately, so that upper management is not surprised and put in the position of having to respond as if it were an emergency.

In order to complete the Level 1 Assessment successfully, decision-makers must be part of the process. The Level 1 Assessment can result in the need for a PWS manager to approve funding to correct a sanitary defect.

Communication, coordination, and cooperation

The three 'Cs' lead to success: communication, cooperation, and coordination.



Small systems and large systems are generally organized very differently. There are some universal communication concepts that apply to any size of system:

- The people in charge need to know what the staff and operators are doing;
- The staff and operators need clear direction on their job, and the tools to do it;
- The people in charge need to make sure money is spent on what is needed;
- Operators and staff have to tell the managers what needs maintenance.

For this to occur, there must be good internal and external communication.

Internal communication

Chains-of-command and communication pathways are a basic part of any organization. Therefore, they are usually documented. A large system should have an organization chart. A small system should have ownership, lease, and/or contract documentation.

Doing the Level 1 Assessment can be challenging in surprising way if there are problems with internal communication. In fact, some Level 1 Assessments are triggered because of a breakdown in communication—for example, when repeats are not collected because communication with a lab is inadequate.

Goal setting

An organization's leadership defines its mission. A part of that mission for a PWS should be to meet the federal and state standards for safe drinking water—with a safety factor. Without that mission, an organization may be set up for failure. It is always easier to get somewhere when the goal is clear.

SOPS

Standard operating procedures (SOPs) are a business standard and a part of any successful PWS. For example, PWSs are required to have a SOP for collecting coliform samples that ensures that the samples are not contaminated.

A PWS's leadership needs to keep the SOP up-to-date, make sure that all staff are trained on how to follow it, and then to make sure that they **are** following it.

For the assessment, in addition to gathering the required coliform sampling SOP and the disinfectant residual sampling SOP, determine whether the SOPs:

- Are up-to-date, and have a review schedule;
- Have been used to train operators, including refresher training;
- Are signed by operators to document that training occurred; and
- Are part of performance requirements.

External communication

With the TCEQ

The Level 1 Assessment has a short turnaround. A PWS has 30 days to complete it after the trigger is hit.

At medium or large PWSs, it is important that a primary point of contact with TCEQ be assigned. The organization will be more successful if the TCEQ knows the right person to talk to—whether that is a manager or operator.

One way to ensure that the TCEQ knows who to talk to is by adding that information to DWW for a PWS Contact. A PWS can update this data by contacting the Water Supply Division at 512-239-4691, or by e-mail to:

PWSINVEN@tceq.texas.gov.

With customers

If a PWS does not complete the Level 1 Assessment within 30 days, the PWS must notify their customers of a violation.

Part 5. Gathering documents to assess

In order to personalize the training, the Level 1 Assessment attachments for the PWS at which the DAM is being performed should be used to illustrate the learning goals throughout the day. Therefore, the PWS should gather those documents prior to the training.

Before the DAM, the PWS should gather documents, including:

- Required attachments that have to be attached to the Level 1 Assessment form when it is sent to the TCEQ, and
- Supporting documentation that you will need to assess during this DAM and during the Level 1 Assessment.

During the introduction, all of the required attachments and supporting documents needed for a Level 1 Assessment will be discussed. These include:

1. **Coliform sample collection SOP** (standard operating procedure)—a *required attachment*;
2. **Disinfection level results** for the month before triggering the assessment, and all of the data collected for the trigger month—a *required attachment*;
3. **Latest CCI report**, including documentation of any items that were required to be corrected based on that investigation;
4. **Regulatory correspondence** with TCEQ—especially if the PWS is under Enforcement, a Corrective Action Plan, or self-audit for PWS activities;
5. Completed **Microbial Submission Report forms** for all positive and rejected samples;
6. **Monitoring plan**, including
    i. The coliform **Sample Siting Plan** (SSP)
    ii. The distribution system **map**;
    iii. If chloramines are present, the **Nitrification Action Plan (NAP)** and last two months of NAP sampling
7. Recent **flushing records**;
8. Distribution operation and maintenance records, for example:
    i. Maintenance work orders, invoices, as needed,
    ii. Pressure and complaint data, if present,
    iii. SOP for **disinfection after repair** and/or construction
9. Additional recent **disinfectant level results,**
10. **Chemical and water usage reports,** if needed to evaluate whether disinfectant is dosed correctly;
11. **Water loss records** to help determine how leaky the system is;
12. **Tank inspection reports** and tank maintenance records, if present;
13. **Cross-connection control program documents**, for example Service Agreements and/or Customer Service Inspection reports;
14. If the PWS operates a SWTP, the **SWMORs** for the two months prior to the month the trigger occurred, and all data collected for the trigger month;
15. Sanitary Control Easements, or a TCEQ-exception-approval letter granting a Sanitary Control Easement exception.

This is a long list—but it is not everything that might be needed. For example, if the PWS fixes a tank, before and after photographs might be needed to document that.

Required attachments

Before a PWS attends this DAM, the operator should gather the two documents that must be attached to every Level 1 Assessment and other supporting documentation.

The two required documents are:

1. **Coliform sample collection SOP** (standard operating procedure)
2. **Disinfection level results** for the month before triggering the assessment, and all of the data collected for the trigger month.

Coliform sample collection SOP (Required Attachment)

Section 2 of the Level 1 Assessment covers coliform sample collection. *Appendix 1 provides additional information about coliform procedures.*

Every PWS should have a coliform collection SOP and follow it. If a PWS finds that their Coliform Sample Siting Plan is outdated, it must be revised to show current procedures and sites. The details for this are discussed under Section 2, below.

Disinfectant residual results (one-month through current) (Required Attachment)

Section 3 of the Level 1 Assessment form covers disinfectant residuals. *Appendix 3 provides additional information about disinfection.*

Distribution disinfection is important for controlling bacteria. TC+ often occurs when disinfection is inadequate. In order to evaluate whether disinfection is a factor in triggering the Level 1 Assessment, it is necessary to look at the disinfectant residual results.

Small systems that serve fewer than 250 connections and fewer than 750 people must collect disinfectant samples weekly; **larger systems** must sample daily (including weekends). Samples must be collected at sites representing the entire distribution system.

In order to evaluate whether the disinfectant residual was low, and could have been a sanitary defect, the assessor must look at data leading up to the TC+ time period. Specifically, the PWS must gather data from the two months before the TC+ happened, plus the data since the data happened, through the date of the assessment.

This data should be copies of the handwritten sheets from the person who collected the samples. Or, if the data is entered into a field PDA, that data must be printed out. If results from any on-line analyzers is used, that must be printed out and attached to the Level 1 Assessment form as well.

If any process management samples are collected, they must also be assessed. Any information that will shed light on the reason for the TC+ must be looked at in the assessment.

If the data is not available, that may be a sanitary defect and/or a violation of TCEQ rules. In that case, a PWS would need to use the CARP to describe how they were going to change to collect and/or retain the required data.

Supporting documentation

There is additional data that must be reviewed for a Level 1 Assessment, but that does not generally need to be submitted with the form. This includes

Regulatory documentation

This includes the latest CCI report and letters from Water Supply Division (WSD)

Required reports

This includes reports that PWSs must have, by rule, like the Plant Operations Manual, Monitoring Plan, Coliform Sample Siting Plan, chemical and water usage reports, Service Agreements, Customer Service Inspection forms, Backflow Prevention Assembly Testing and Maintenance forms, etc.

Monitoring data

Coliform and chlorine residual monitoring data from recent months is important to the assessment.

Latest CCI report

Most of the items on the Level 1 Assessment form are related to rule requirements of 30 TAC Subchapter items that are reviewed during CCIs. The assessor will want to look at those reports to make sure that nothing noted in those reports as an issue is still an issue.

Regulatory correspondence

Section 8 of the Level 1 Assessment form asks about compliance status.

The TCEQ corresponds by mail regarding violations of PWS rules. The assessor will want to review that correspondence to ensure that any items related to the scope of the Level 1 Assessment are considered during the Level 1 Assessment.

Correspondence from the TCEQ about the Level 1 Assessment will be sent to the administrative contact person shown in Drinking Water Watch (DWW) at:

dww2.tceq.texas.gov/DWW/

A PWS can update this data by contacting the Water Supply Division at 512-239-4691, or by e-mail to PWSINVEN@tceq.texas.gov.

Monitoring Plan

Every PWS is required to have a Monitoring Plan (§290.121). The Monitoring Plan brings together all of the PWS's sampling requirements in one place.

If the Monitoring Plan is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to the Monitoring Plan in the CARP.

Distribution map

An important part of the Monitoring Plan is the distribution map. In order to track trends and issues, one needs to be able to see the broad view which only a map provides.

The Monitoring Plan's distribution map must show coliform and disinfection sample sites, major distribution lines/pipes, all storage, treatment plants, interconnections with other PWSs, pressure planes, the area served (for example, the city limits, district boundaries, or Certificate of Convenience and Necessity boundaries) and anything else that may relate to water age.

- A **small system** must submit the entire Monitoring Plan and the map of the entire system.
- A **large system** must submit the distribution system portion of the Monitoring Plan, a map of the system showing that sites are representative of the entire system, and a detail map (such as a route map) legibly showing the area where the TC+ occurred.

(For the purposes of the Level 1 Assessment 'large' and 'small' are not specifically defined. If you do not know how to characterize your PWS, consult with the TCEQ.)

The TCEQ has guidance for Monitoring Plans in Regulatory Guidance (RG) 384.

www.tceq.texas.gov/publications/rg/rg-384.html

If the distribution map is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to the distribution map in the CARP.

Coliform Sample Siting Plan

Section 2 of the Level 1 Assessment form asks about the coliform SSP.

Appendix 1 provides additional information about coliform procedures.

Another part of the Monitoring Plan that must be attached to the Level 1 Assessment form is the Coliform Sample Siting Plan. This is the list of routine and repeat coliform sample sites. The format that must be used for the Coliform Sample Siting Plan is on TCEQ's web site at:

www.tceq.texas.gov/drinkingwater/microbial/revised-total-coliform-rule

Under the RTCR, repeat sampling is not done at progressively distant locations. Instead, PWSs must select specific repeat sites, and take all required repeats at those locations. Additional, alternate repeat sites may also be selected, just in case the repeat site can't be used when repeat sampling is needed.

Generally, the designated at least one repeat sample site must be identified within *"5 connections upstream and 5 connections downstream."* This sounds simple but sometimes it's not. In an industrial complex, connections may be thousands of feet apart, as compared with a normal residential area where they are hundreds of feet apart. Or, sometimes the routine sample site is the last available connection on a line. In those cases, logic prevails. If an non-standard condition is present, the PWS

has the option of describing an alternate SOP for taking repeats there. For example, in the situation of the routine site at the end of the line, the PWS would be allowed to have an SOP for taking sequential samples instead of a 'downstream' sample.

If a PWS finds that their Monitoring Plan is outdated, it must be revised to show current procedures and sites. The PWS should ensure that selected sample sites represent the entire distribution system, that the site type is appropriate for what is being sampled, that the list is complete, and that the map has all sites shown clearly and correctly corresponding to the current list.

If the coliform Sample Siting Plan is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to the coliform Sample Siting Plan in the CARP.

Flushing records

Section 3 of the Level 1 Assessment form asks about flushing.

Appendix 7 provides additional information about flushing.

Stagnant water can harbor bacteria, causing a sanitary defect.

Since 1956, every PWS in Texas has been required to flush dead-end mains monthly and retain records of flushing for three years. Flushing helps reduce water age: water age is a common cause of water quality degradation. Over time, the disinfectant residual decays, and bacteria can regrow.

Process management data on flushing should be available as operator logs or notes. This data should be copies of the handwritten sheets from the person who flushed dead-end mains. Or, if the data is entered in in an electronic device, that data must be printed out. If results from any auto-flushers are used, that must be printed out as well.

If any process management flushing was performed, that data must also be assessed. Any information that will shed light on the reason for the TC+ must be looked at in the assessment.

If the data is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to data collection and retention in the CARP.

Chemical and water usage reports

Section 6 of the Level 1 Assessment form asks about treatment.

Disinfection is a critical barrier to pathogens. Its failure is a frequent sanitary defect.

If the only treatment provided is chlorination, it may be necessary to review chemical and water usage reports in order to evaluate whether treatment was adequate. This is especially true if residual monitoring is inaccurate or not complete.

If the data is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to data collection and retention in the CARP.

Water loss records

Section 3 of the Level 1 Assessment form asks about leakage.

The assessor should review documentation to determine whether leaks persist in the distribution system, especially if it is possible that leaks could have contributed to bacterial contamination of the distribution pipes.

Many PWSs are required to track water loss and report it to the Texas Water Development Board and will have those records easily at hand.

Other PWSs have conservation requirements because of droughts which include documentation of water loss. Depending on the current drought stage, these records may or may not be available.

It is unlikely that water loss or failure to track it will be cited in a CCI, unless other capacity issues exist, so recent CCI reports won't document this information.

All PWSs have an economic interest in tracking water loss. Producing drinking water costs money, and losing it is like throwing money on the ground. PWSs, like all fiscal entities, have a responsibility to use money sanely. Ignoring water loss is fiscally imprudent. A PWS that is taking active measures to control budgets may have documentation related to water loss as part of that effort.

Cross-connection control program documents

Section 3 of the Level 1 Assessment form asks about backflow and cross connections.

Appendix 5 provides additional information on cross-connection control.

For example Service Agreements and/or Customer Service Inspection reports;

If the data is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to data collection and retention in the CARP.

Nitrification Action Plan (NAP)

Section 3 of the Level 1 Assessment form asks about nitrification.

Appendix 4 provides additional information about nitrification.

All PWSs that use chloramines are required to use a Nitrification Action Plan (NAP) to prevent and control nitrification [§290.46(z)]. Systems that ONLY have free chlorine are not required to answer these questions.

Nitrification occurs when nitrifying bacteria 'eat' ammonia and make nitrite and nitrate, causing rapid loss of disinfectant residual.

Systems with chloramines must collect data in addition to the total chlorine residual. That data is associated with the NAP goals, baselines, and triggers. The

most recent two months, plus current data through the time of the assessment must be gathered.

If the NAP is not being used, or if data is not available, that may be a sanitary defect and/or a violation of TCEQ rules. In that case, a PWS would need to use the CARP to send in a revised NAP and description of chloramination monitoring.

The TCEQ has information about nitrification on the web site at:

www.tceq.texas.gov/drinkingwater/disinfection/nitrification.html

This site provides instructions on how to develop a NAP, and has a Microsoft Excel template for creating a NAP. The TCEQ can provide free, on-site assistance through the FMT assistance program—by calling TCEQ at 512-239-4691.

If the data is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to data collection and retention in the CARP.

Tank inspection reports

Section 4 of the Level 1 Assessment form deals with tanks.

Every tank in Texas must be inspected periodically, so the assessor should look at those records.

If the data is not available, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary to describe corrections to data collection and retention in the CARP.

Surface water treatment plants (SWTPs)

Section 6 of the Level 1 Assessment form asks about treatment.

RG-211 provides additional information about surface water treatment.

All PWSs that operate a surface water treatment plant (SWTP) submit Surface Water Monthly Operating Reports (SWMORs) every month. The SWMOR documents the SWTP's success in removing and inactivating microbes.

A PWS that operates a SWTP should review SWMORs for the two months before the month the trigger happened. Also, all of the daily data collected up to and including the trigger date must be submitted with the Level 1 Assessment form.

If a PWS is not completing SWMORs, that may be a sanitary defect and/or a violation of TCEQ rules, which may be documented in recent investigation reports and/or regulatory correspondence. It may be necessary for the CARP to describe corrections to data collection and retention and document how SWMORs will be completed in future.

TCEQ's RG-211 provides detailed assistance with SWMORs. It is available on the TCEQ's web site at:

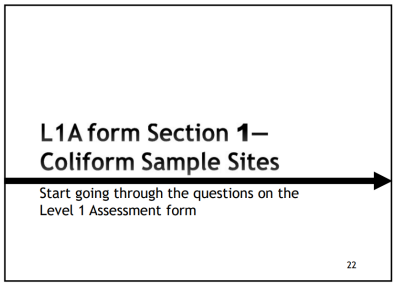
www.tceq.texas.gov/drinkingwater/swmor/swmor/swmor-forms-and-instructions

Overview Review Questions

- ❑ Do you know the definitions of
  - Sanitary defects,
  - Additional issues, and
  - False positives?
- Scope of Level 1 Assessment?
- Assessment process?
- Roles and responsibilities?
- The documents needed to assess a PWS?

21

Section 1—Coliform Sample Sites



In order to ensure that the data is conveying true and correct information, coliform sample sites must be chosen with care. If unsanitary sites are used, samples may be contaminated with coliform that is NOT in the distributed drinking water. This is undesirable because bad data leads to bad decisions—for example, if time is wasted following up on TC+ that didn't really happen, operators may not have time to do other needed tasks.

Any PWS that triggered a Level 1 Assessment should take a close look at the locations where TC+ was found.

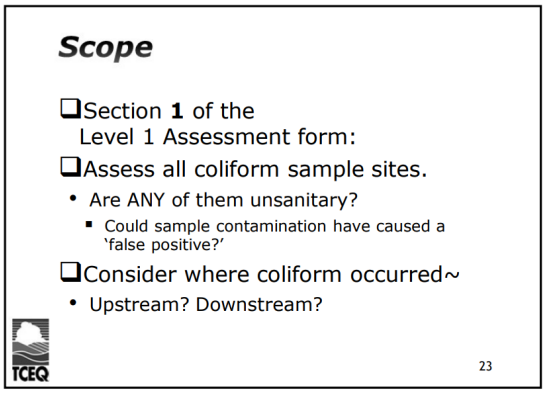
Scope

This section covers Section 1 of the Level 1 Assessment form, coliform sample sites.

Only one copy of Section 1 is provided in the Level 1 Assessment form, but you will need to assess all of the sites where TC+ was found.

The Level 1 Assessment Work Sheet in Appendix 11 provides pages to take notes on four (4) sites. Make additional copies if needed. Label the forms clearly with the location assessed.

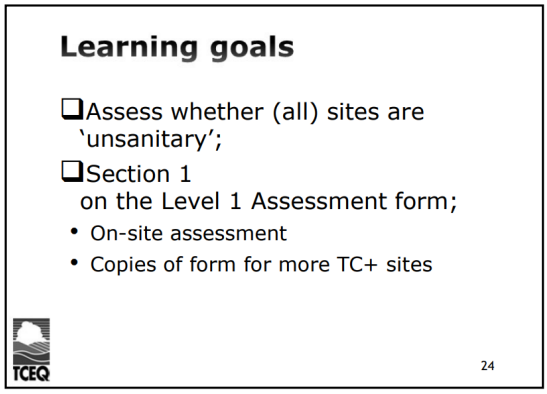
If the assessor does not have expertise related to the coliform monitoring, it is recommended that they seek expert assistance.



Learning goals

Learning goals for this workshop include:

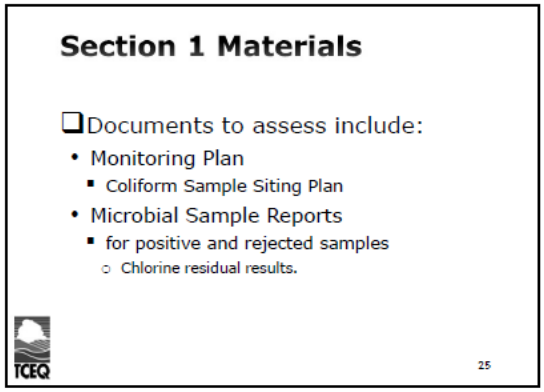
- Understand what it means to have a 'unsanitary' sample site;
- Become familiar with Section 1 on the Level 1 Assessment form;
- Become familiar with regulatory and non-regulatory sanitary defects associated with sample sites;
- List all of the sites with positive (and rejected) samples; and
- Be prepared to make copies of the form and assess each sample site where TC+ was detected.

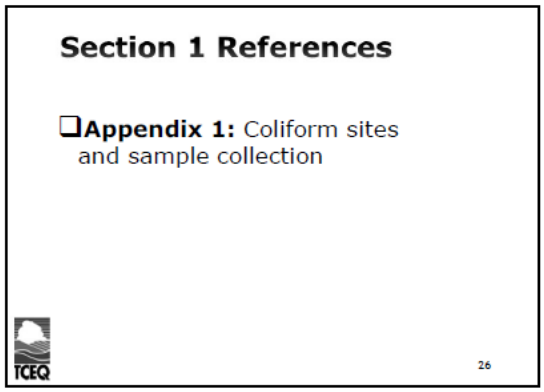


Supporting documentation to review

The following attachments will be discussed during this portion of the DAM:

- ✓ Monitoring Plan;
- ✓ including Coliform Sample Siting Plan and
- ✓ Distribution map;
- ✓ Microbial Sample Reports for positive and rejected samples; and
- ✓ Recent disinfectant residual results.



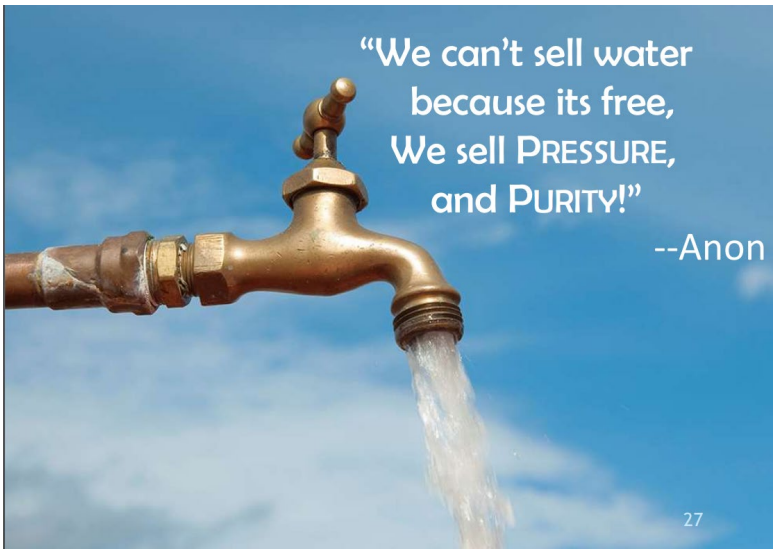


Section 1 of the form

Section 1 of the Level 1 Assessment form is shown in Figure 1.

Section 1 – Coliform Sample Sites *(Location of the sample sites that were total coliform-positive)*	Yes	No	N/A
1. Does the sample tap(s) have a Point of Use (POU) treatment device installed?	☐	☐	
2. Was it determined that any plumbing repairs and/or additions were made at this sampling site?	☐	☐	
3. Is the sampling tap or site unsanitary? (i.e., sample tap and area around the sample tap should be: clean and dry; free of animal droppings; located adequate distance from spray irrigation systems or other contaminants; and free of excessive vegetation or other impediments to sample collection, etc.)	☐	☐	
4. Is the height of the sample tap above grade and not positioned close to the ground?	☐	☐	
5. Is the sample tap subject to flooding and/or excessive surface runoff?	☐	☐	
6. Does the sampling tap have a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator?	☐	☐	
7. Is the sample tap located on or near a dead end main?	☐	☐	
8. Is the sample tap (faucet) located on an interior location that is used for other activities? (i.e., kitchen, janitorial, or commercial sinks, etc.)	☐	☐	
9. Is the sample tap in good condition and free of leaks around the stem or packing?	☐	☐	
10. Can the sample tap be adjusted to obtain an even low-flow of water without excessive splash during sample collection?	☐	☐	

Figure 1. Section 1—Coliform Sample Sites on the Level 1 Assessment form.



List of sites

Often, when a PWS triggers a Level 1 Assessment, TC+ occurred at multiple sites. Each site must be assessed. Section 1 must be completed and submitted for each site.

It is very helpful to list these sites, so a table for that is provided below, and in the Level 1 Assessment Work Sheet. Extra forms for documenting the assessment of each site are also on the Level 1 Assessment Work Sheet in Appendix 11

Table of TC+ sites

Table 1 provides a place for PWSs to list all of the TC+ locations. It is highly recommended that sites with rejected samples also be assessed.

Table 1. List of sites with TC+

Site # on list	Address (or location	Routine or repeat	Sanitary?	Dates of TC+
Example Site x	*1231 Main Street (City Hall)*	*Routine*	*Yes*	*4/1/16*
Site 1				
Site 2				
Site 3				
Site 4				

(Add additional lines if needed.)

TC+ sites in Drinking Water Watch

To double check on whether all sites have been assessed, the assessor can check on Texas Drinking Water Watch.

First, select the PWS being assessed on the main Texas Drinking Water Watch web page at:

dww2.tceq.texas.gov/DWW/

Figure 2 shows the first page, where you can select the PWSID or the name of the system to search for it.

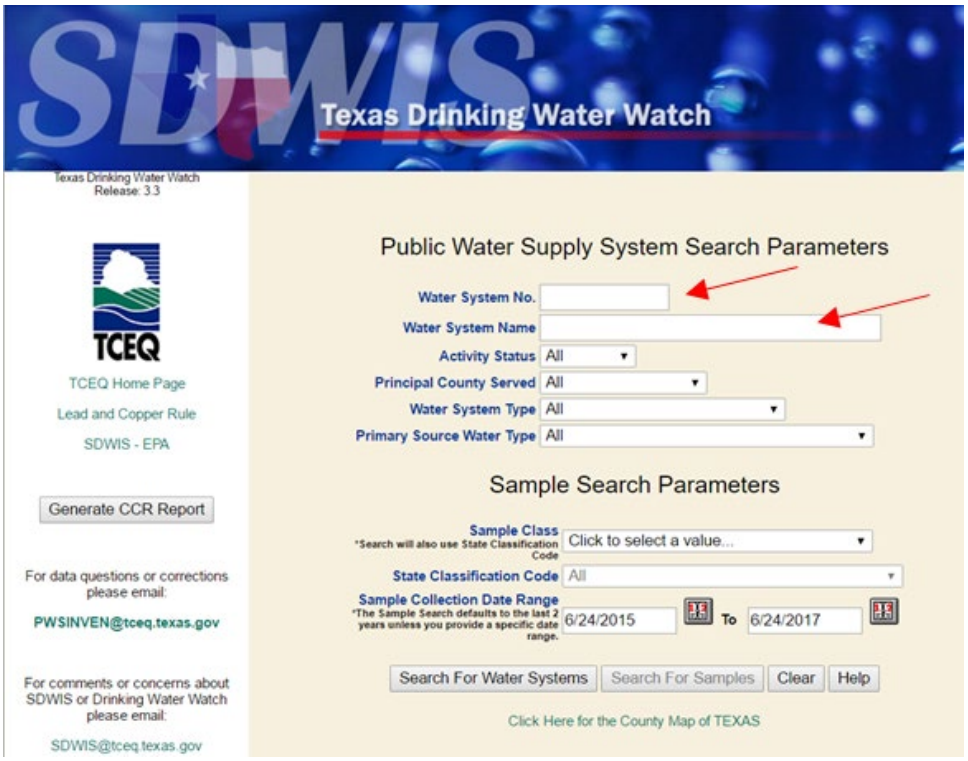
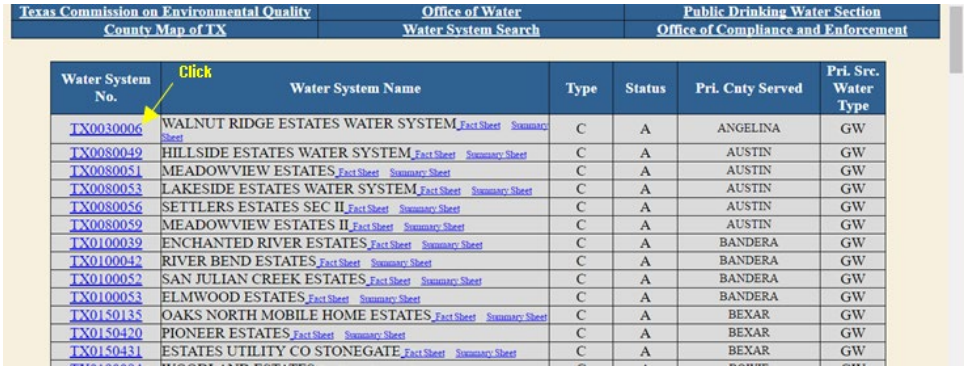


Figure 2. The first page of Texas Drinking Water Watch web site, showing where to enter the PWSID OR name to search.

Figure 3 shows an example of the search results. Searching for the word "Estate" brings up a list of systems. From these results, clicking on the PWSID will lead to the Water System Detail page.



Water System No.	Water System Name	Type	Status	Pri. Cnty Served	Pri. Src. Water Type
TX0030006	WALNUT RIDGE ESTATES WATER SYSTEM Fact Sheet Summary Sheet	C	A	ANGELINA	GW
TX0080049	HILLSIDE ESTATES WATER SYSTEM Fact Sheet Summary Sheet	C	A	AUSTIN	GW
TX0080051	MEADOWVIEW ESTATES Fact Sheet Summary Sheet	C	A	AUSTIN	GW
TX0080053	LAKESIDE ESTATES WATER SYSTEM Fact Sheet Summary Sheet	C	A	AUSTIN	GW
TX0080056	SETTLERS ESTATES SEC II Fact Sheet Summary Sheet	C	A	AUSTIN	GW
TX0080059	MEADOWVIEW ESTATES II Fact Sheet Summary Sheet	C	A	AUSTIN	GW
TX0100039	ENCHANTED RIVER ESTATES Fact Sheet Summary Sheet	C	A	BANDERA	GW
TX0100042	RIVER BEND ESTATES Fact Sheet Summary Sheet	C	A	BANDERA	GW
TX0100052	SAN JULIAN CREEK ESTATES Fact Sheet Summary Sheet	C	A	BANDERA	GW
TX0100053	ELMWOOD ESTATES Fact Sheet Summary Sheet	C	A	BANDERA	GW
TX0150135	OAKS NORTH MOBILE HOME ESTATES Fact Sheet Summary Sheet	C	A	BEXAR	GW
TX0150420	PIONEER ESTATES Fact Sheet Summary Sheet	C	A	BEXAR	GW
TX0150431	ESTATES UTILITY CO STONEGATE Fact Sheet Summary Sheet	C	A	BEXAR	GW

Figure 3. An example of the search results in Texas Drinking Water Watch—searching for communities with the word 'Estate' in their name.

Figure 4 shows an example of the Water System Detail page. The four columns of yellow text on this page are links you can click to get additional information.

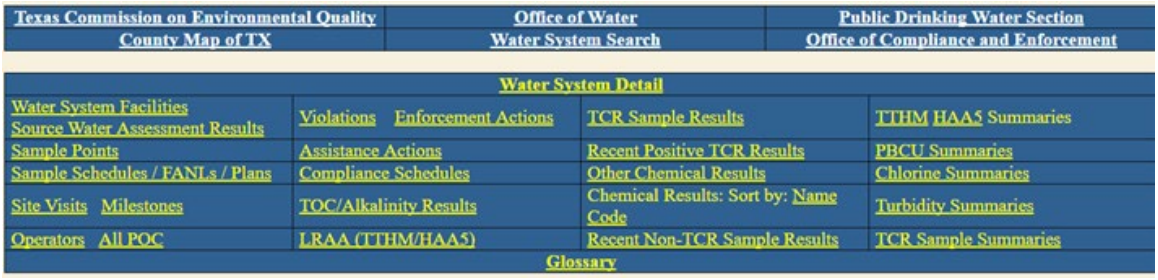


Figure 4. An example of the Water System Detail page, noting the links at the top of the page.

On the Water System Detail page, clicking on the "Recent Positive TCR Results" link (link in the third column, second down) will bring up a list of the recent TC+ samples.

Figure 5 shows an example of the "Recent Positive TCR Results" page. Figure 2-3b shows how to see the chlorine residual for a coliform sample.

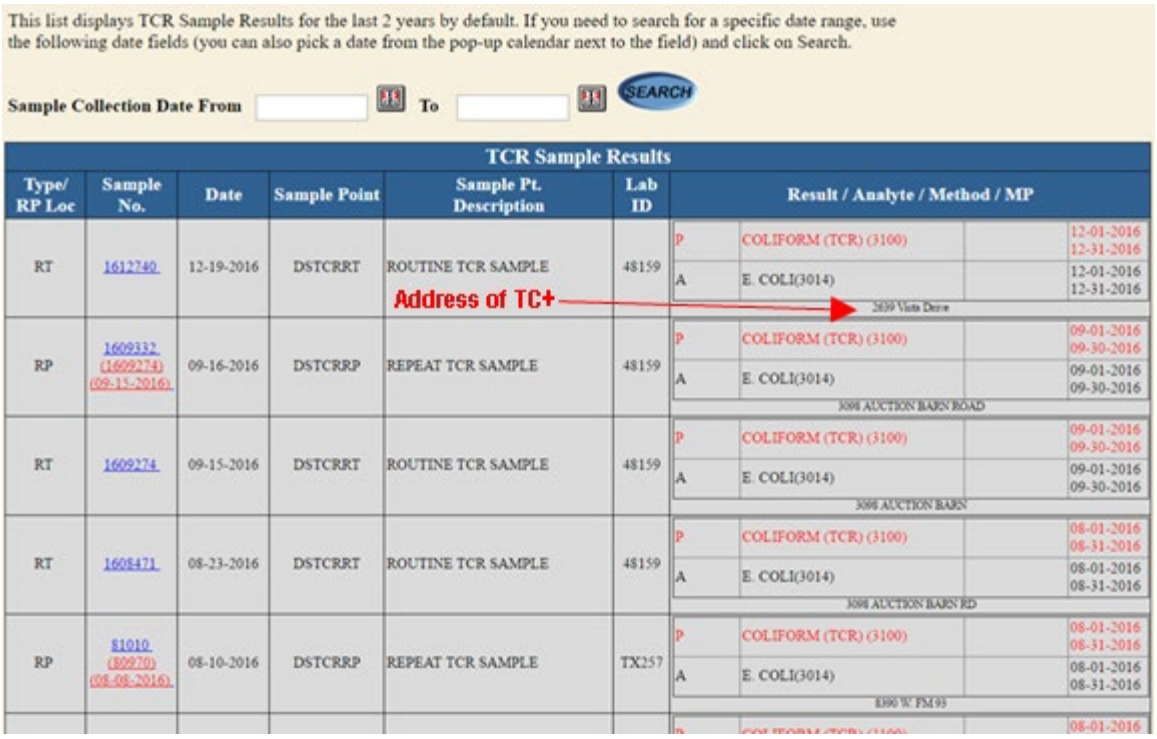


Figure 5. An example of the TCR Results page.

On the TCR Sample Result page, clicking on the Sample No. brings up a detail page with the chlorine residual measured with the coliform sample (Figure 6.)

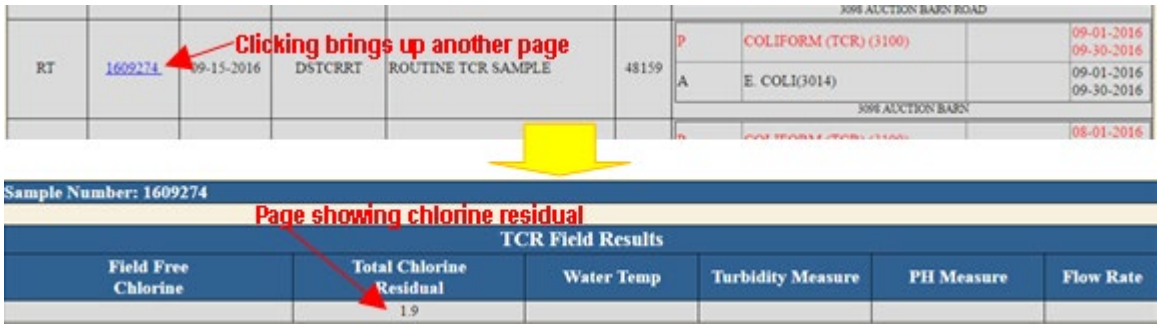


Figure 6. The chlorine residual measured with the coliform sample.

Assessment process summary: Coliform sample sites

In order to assess coliform sample sites, the assessor will consider all sites where positive results. It is highly recommended that sites where samples were rejected also be assessed. For **each site**, the assessment process will include:

- Review data,
    - Chain-of-custody documentation on the Microbial Sample Report, (including disinfectant residual data),
    - Maintenance or repair data, if present,
    - Pressure records, complaints, if present
    - Distribution map (to determine proximity to dead ends)
    - And any other available pertinent data,
- Visit sites:
    - Verify monitoring data, like pressure and/or chlorine residual,
    - Evaluate whether sites are sanitary—consider
        - Subject to flooding?
        - Clean, good condition?
        - Attachments?
        - Flow rate?
    - Take pictures (recommended),
- Gather additional data if needed—for example,
    - Find out if the sample tap has a point-of-use device upstream;
- Review compliance data, if present;
- Document any sanitary defects or additional issues in the CARP..

If the assessor does not have experience with coliform sampling, it is recommended that they seek expert assistance.

While proceeding through these steps, the assessor should be vigilant in looking for ways that coliform could have gotten into the distributed drinking water. But also, they should look for ways that the sample could have been contaminated, causing a false positive. It is in the PWS's best interest to correct sanitary defects to protect public health. It is in the best interest of a PWS to not have false positives, to avoid scaring customers unnecessarily

This section is related to the observation of the sites where TC+ was found. One concern is that an unsanitary site could cause a 'false positive' result. For example,

if animal feces is present in the yard around a hose bibb used for sampling, it may indicate that the feces could become airborne and contaminate sample, or that an animal could urinate on the hose bibb itself.

Reviewing lab 'rejects' can help determine whether a site is questionable. Unsuitable samples that are rejected by the lab are caused by water issues. Frequent 'rejects' at a specific site may indicate unsanitary conditions. It is recommended that a PWS investigate the reason for a sample that is too dirty to analyze.

The way to truly assess whether a site is sanitary is to perform an on-site assessment of the sample sites where TC+ occurred, and to evaluate previous data to see if bad samples had occurred there before.

Unsanitary sites

Collecting coliform samples at a place where coliform can get into the sample from some other source than the distribution water can cause false positives. False positives are undesirable because they don't accurately represent the actual quality of the water folks are drinking. They raise an alarm when one is not necessary—like the boy who cried wolf.

The area of the distribution system that should be assessed depends on the system configuration along with the extent of coliform positive samples.

- **Smaller** systems would be expected to have fewer distribution system components and therefore a lesser level of effort in completing the assessment.
- **Larger** systems may focus their evaluation on areas of the system that have been shown to be more greatly affected, particularly if the data review confirms that the spread of contamination has been limited.

The evaluation of the sample site(s) with the positive sample(s) and the sampling protocol would be performed in a similar manner for systems of all sizes and types. The sample site(s) is/are a key indicator of whether the problem is system-wide or localized.

The assessor should go to each site and observe it to determine if it is unsanitary. Some examples of things you might see nearby that can indicate unsanitary conditions include,

- Wet, dirty surroundings,
- Animal droppings,
- Spray irrigation systems; and
- Excessive vegetation, etc.

Sanitary sites—overview

All PWSs should select sanitary coliform sites.

Generally speaking, sanitary sites:

- Have clean, dry, well-maintained taps and sample lines.

- Have sample taps that are free from excessive vegetation and are at least 18” above the surface of the ground.
- Are located where livestock do not graze, and dogs can't pee on them.
- Are located in areas that do not harbor vermin.
- Are used frequently enough that stagnant water in premise plumbing will not impact sample results.

Some of the common items that should be evaluated at the sample site(s) include:

- Cleanliness and suitability of the sample tap or sink,
- Potential for hot water to enter the sample through the tap, and
- Conditions that may have changed at the sample site since the last sample collection, such as:
    - New uses for the sink as janitorial cleanup area,
    - Dirt accumulation near the faucet, or
    - Installation of a point-of-use device on the faucet.

Systems with unsanitary sites must correct that situation. Options include cleaning up the site or selecting new, sanitary sample sites to replace the unsanitary sites.

If sites are changed, the coliform sample sites must be updated in the Monitoring Plan. Also, for a new location, ‘upstream’ and ‘downstream’ repeat locations must be selected and documented on the coliform sample siting plan. The PWS should train the operators collecting the samples on how to identify unsanitary conditions so that the problem does not happen again.

Questions in Section 1

Section 1 includes 10 questions that must be answered for EACH site where TC+ was found.

REMEMBER-Label each page
Clearly note the location of each sample sites that was TC+ at the top of each individual form

Table 2 lists the Section 1 questions individually, with the 30 TAC citation where applicable, a description of potential sanitary defects, and a description of a potential corrective action.

Table 2. Questions on Section 1 of the Level 1 Assessment form

Section 1–Coliform Sample Sites	Yes	No	N/A
Question 1-1. *AT THIS SITE:* Does the sample tap(s) have a point of use (POU) treatment device installed?	☐	☐	
1-1. Potential sanitary defect Problems related to point-of-use devices that are installed upstream of coliform sample taps include: • Stagnant water in softeners can cause TC+. • Point-of-use filters that are not replaced or routinely maintained can become super-saturated with microbes and contaminants causing TC+. • Point-of-use filters often remove disinfectant residuals making the sample water collected downstream of them more susceptible to coliform growth or contamination. As part of the Level 1 Assessment, a PWS should determine whether there are any softeners or other point-of-use treatment devices installed upstream of a sample tap where a TC+ occurred. This applies to sample taps on active service connections; it would not apply to dedicated sample stations. One way to determine this is to perform a Customer Service Inspection (see Workshop 6). Another is to contact the customer and ask. **1-1. Answers** If a treatment device is determined to be present upstream of one of the TC+ taps, the assessor should answer '**Yes**.' If that treatment could have caused the TC+ and whether anything was done to correct that in the **CARP**. If the Monitoring Plan is changed to replace a routine or repeat site, that should be kept on site for review by regional investigators. If no treatment device is present at a TC+ tap, the PWS would answer '**No**.'			
1-1. Rule requirement The applicable rules include 290.109(c) and 290.46(m).			
1-1. Correction options It is recommended that a PWS choose to select new sample sites to replace those where treatment devices upstream could cause false positives. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated. It is not in either the PWS's or the TCEQ's interest to get inaccurate data.			

Section 1–Coliform Sample Sites	Yes	No	N/A
Question 1-2. *AT THIS SITE:* Was it determined that any plumbing repairs and/or additions were made at this sampling site?	☐	☐	

1-2. Potential sanitary defect

This question asks about plumbing repairs made to premise plumbing that could impact the site. Section 3 asks about construction and repair on the distribution side of the meter.

If construction or plumbing loosened sediment or created stagnant water before the tap, it could cause either actual contamination or 'false positives.' (Although we call these 'false positives,' they really show coliform is present, but not that coliform is in the distribution water, just that coliform is present in that house or business.)

1-2. Answers

If construction occurred on the customer's side of the meter at this tap, answer '**Yes**.' In this case, describe whether this could have caused the TC+ and whether anything was done to correct that in the **CARP**. If the Monitoring Plan is changed to replace a routine or repeat site, that should be mentioned in the **CARP** and the Monitoring Plan should be kept on site for review by regional investigators.

If not, answer '**No.**'

1-2. Rule requirement

The applicable rules include 290.109(c) and 290.46(m).

1-2. Correction options

If construction or repair just impacted the site temporarily, it may not be necessary to make any corrections.

However, it is recommended that a PWS choose to select new sample sites if activities upstream of the sample tap will be ongoing. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated. It is not in either the PWS's or the TCEQ's interest to get inaccurate data.

Question 1-3. *AT THIS SITE:* Is the sampling tap or site unsanitary? (i.e., sample tap and area around the sample tap should be: clean and dry; free of animal droppings; located adequate distance from spray irrigation systems or other contaminants; and free of excessive vegetation or other impediments to sample collection, etc.)	☐	☐	

1-3. Potential sanitary defect

This general question includes the details in questions 1-1, 1-2, and 1-4 through 1-10. If any of the items in those questions identifies an unsanitary condition, this question will also probably reflect that unsanitary condition.

As previously discussed, unsanitary sites can lead to false positives.

1-3. Answers

If the answer to any of the questions in 1-1, 1-2, and 1-4 through 1-10 is '**Yes,**' then the answer to this question is probably 'Yes'. If there are other unsanitary conditions, the answer would also be '**Yes'**. Unsanitary sites and their correction should be explained in the **CARP**.

If this site is sanitary, the answer is '**No'**.

Section 1–Coliform Sample Sites	Yes	No	N/A
1-3. Rule requirement The applicable rules include 290.109(c) and 290.46(m).			
1-3. Correction options It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.			
Question 1-4. *AT THIS SITE:* Is the height of the sample tap above grade and not positioned close to the ground?	☐	☐	
1-4. Potential sanitary defect If the tap is below grade, or close to the ground, it may be contaminated with rain water either inundating it or splashing dirt (and pathogens) up onto it. As previously discussed, unsanitary sites can lead to false positives. **1-4. Answers** If the tap is below grade or close to the ground, the answer is '**Yes'** Unsanitary sites and their correction should be explained in the **CARP**. If this tap is high enough above grade to avoid splashing, dogs peeing, or inundations, the answer is '**No'**.			
1-4. Rule requirement The applicable rules include 290.109(c) and 290.46(m).			
1-4. Correction options It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.			
Question 1-5. *AT THIS SITE:* Is the sample tap subject to flooding and/or excessive surface runoff?	☐	☐	
1-5. Potential sanitary defect If the tap is subject to flooding and/or excessive surface runoff, it can be contaminated. As previously discussed, unsanitary sites can lead to false positives. **1-5. Answers** If the tap is subject to flooding and/or excessive surface runoff the answer is '**Yes'** Unsanitary sites and their correction should be explained in the **CARP**. If this tap is not subject to flooding and/or excessive surface runoff, the answer is '**No'**.			
1-5. Rule requirement The applicable rules include 290.109(c) and 290.46(m).			
1-5. Correction options It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.			

Question 1-6. *AT THIS SITE:* Does the sampling tap have a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator?	☐	☐	
1-6. Potential sanitary defect If the tap has a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator, bacteria may grow in that. As previously discussed, unsanitary sites can lead to false positives. **1-6. Answers** If the tap has a swivel-type faucet or similar "Y" type attachment/connection, or is equipped with an aerator, the answer is '**Yes'** Unsanitary sites and their correction should be explained in the **CARP**. If this tap is high enough above grade to avoid splashing, dogs peeing, or inundations, the answer is '**No'**.			
1-6. Rule requirement The applicable rules include 290.109(c) and 290.46(m).			
1-6. Correction options It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.			
Question 1-7. *AT THIS SITE:* Is the sample tap located on or near a dead end main?	☐	☐	
1-7. Potential sanitary defect If the tap is located at a dead-end main, it may or may NOT be a problem. If stagnant water occurs near that dead end, it is a problem. It water quality is not degraded, and sediment is not observed in the flushed water, it is not a problem. The assessor should review data to see if dead-end main flushing data documents inadequate residual or the presence of sediment. As previously discussed, unsanitary sites can lead to false positives. **1-7. Answers** If the tap is at or near a dead-end main, the answer is '**Yes'**. If that dead-end main is prone to stagnation or sedimentation, the site may be unsanitary, and unsanitary sites and their correction should be explained in the **CARP**. If this tap not at or near a dead-end main, the answer is '**No'**.			
1-7. Rule requirement The applicable rules include 290.109(c) and 290.46(m).			
1-7. Correction options Hel It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.			

Question 1-8.
AT THIS SITE: Is the sample tap (faucet) located on an interior location that is used for other activities? (i.e., kitchen, janitorial, or commercial sinks, etc.)

☐ ☐

1-8. Potential sanitary defect

If the tap is at an inside faucet near one of the listed activities, it may become contaminated. Usually, these sites have been selected because there are not a lot of choices for site locations.

The assessor should observe the location to see where contaminated water could splash onto the sample tap.

As previously discussed, unsanitary sites can lead to false positives.

1-8. Answers

If the tap inside, on a sink (as described), the answer is '**Yes'**. If the tap is in a place where it could have dirty water splashed on it, the site may be unsanitary, and unsanitary sites and their correction should be explained in the **CARP**.

If this tap not at an inside sink, the answer is '**No'**.

1-8. Rule requirement

The applicable rules include 290.109(c) and 290.46(m)..

1-8. Correction options

It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.

Question 1-9.
AT THIS SITE: Is the sample tap in good condition and free of leaks around the stem or packing?

☐ ☐

1-9. Potential sanitary defect

If the tap is leaky, it may be poorly maintained and contaminated. And, as the saying goes, "If it leaks out, it can leak in!"

The assessor should observe the location to see if leaks could lead to unsanitary conditions.

As previously discussed, unsanitary sites can lead to false positives.

1-9. Answers

If the tap is leaky or in poor conditions, the answer is '**No'**. The tap may be unsanitary. Unsanitary sites and their correction should be explained in the **CARP**.

If this tap is in good condition and free of leaks around the stem or packing, the answer is '**Yes'**.

1-9. Rule requirement

The applicable rules include 290.109(c) and 290.46(m).

1-9. Resources and recommendations

It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.

Question 1-10. *AT THIS SITE:* Can the sample tap be adjusted to obtain an even low-flow of water without excessive splash during sample collection?	☐	☐	

1-10. Potential sanitary defect

If it is not possible to get a 'pencil-thin stream' of water when sampling, excess flow could splash out the preservative and allow chlorine to remain in the sample, leading to a potentially rejected sample, or—if the sample is analyzed—inaccurate results.

If the sample site is a hydrant, but the sampler ALWAYS uses a hydrant sampler when collecting samples, this would make the sample procedure acceptable.

1-10. Answers

If the tap cannot be adjusted to obtain a 'pencil-thin stream', the answer is '**No'**. The tap may be unsanitary. Unsanitary sites and their correction should be explained in the **CARP**.

If the sample tap can be adjusted to obtain an even low-flow of water without excessive splash during sample collection, the answer is '**Yes'**.

1-10. Rule requirement

The applicable rules include 290.109(c) and 290.46(m).

1-10. Correction options

It is recommended that a PWS choose to select new sample sites to replace unsanitary ones. In that case, the PWS's Monitoring Plan and coliform sample siting plan would need to be updated.

If a hydrant is used for a sample site, it is highly recommended that a hydrant sampler be used during sampling.

It is not in either the PWS's or the TCEQ's interest to get inaccurate data.

Remember, this part of the form must be completed for every site where positive samples occurred. Best practice is to also evaluate every site where samples were rejected.

Once the evaluation of the sample site(s) has been completed, the Assessor should evaluate the area of the distribution system near the positive samples. This part of the assessment is designed to help determine if there is a sanitary defect causing the contamination, understand the potential movement of contamination and proactively prevent future coliform positive samples.

Section 1 Review Questions

- ❑ Do you know sites where TC+ was found?
  - Have you visited them yet?
- ❑ Were unsanitary conditions present?
  - Were any fixed?
- ❑ Are there any questions remaining about sites where TC+ was found?

TCEQ

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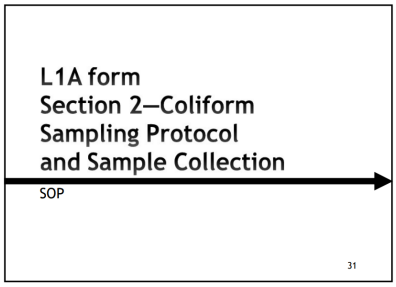
Notes

Section 2—Coliform
Sampling Protocol and Sample Collection



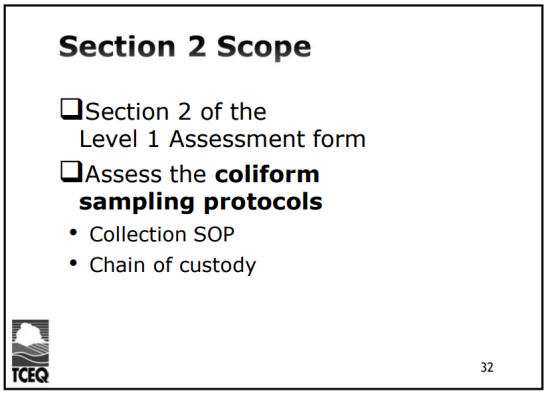
Coliform detection through sampling is a primary focus of the RTCR. Coliform presence is a potential indicator that water quality has degraded, or harmful contaminants may have entered the distribution system water. TC+ is an 'indicator' of potential pathogens.

Standard operating procedures (SOPs) are an integral part of every task that requires a consistent output. Sampling is definitely one of these tasks.

Scope

The questions in this section are intended to guide an Assessor through the key requirements related to coliform sampling, and to determine whether coliform sampling practices could have led to inaccurate sample results.

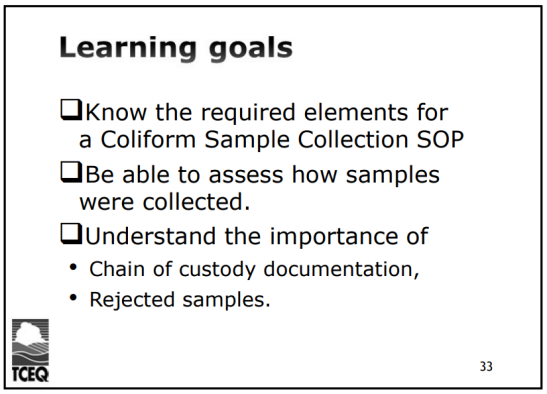
Systems should be careful not to jump to the conclusion that the sampling process caused the coliform detection before the other elements have also been assessed and ruled out as a possible source of contamination. Research has proven that less than 2% of positive results can be explained by inadequate sampling procedures.



Learning goals

The learning goals for Section 2 are:

- Know the required elements for a Coliform Sample Collection SOP and understand that using it ensures that samples are collected consistently and correctly;
- Be able to assess whether operators follow SOPs; and
- Be able to determine whether the absence of an SOP, of failure to follow an existing SOP, could have caused TC+(s).



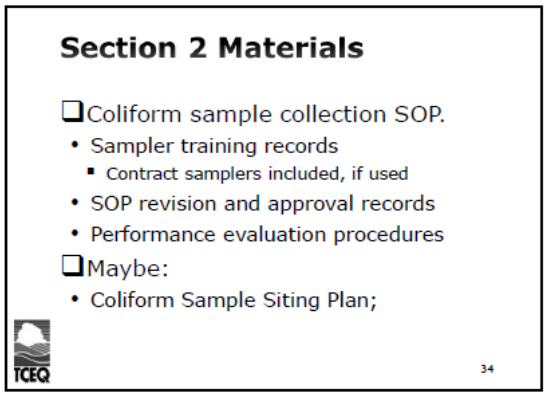
Materials and supporting documentation

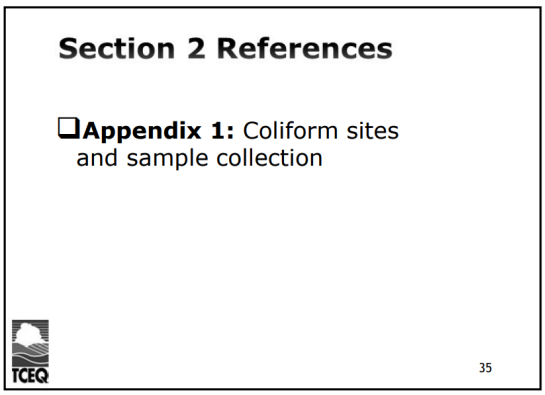
The main document for this section is:

- ✓ The coliform sample collection SOP.

Other documents that may help the assessor assess whether sample collection was performed adequately include:

- ✓ Coliform Sample Siting Plan;
- ✓ Records of training operators regarding the SOP;
- ✓ Records of updating the SOP;
- ✓ PWS requirements for implementing dissemination and review of SOPs;
- ✓ Performance evaluation procedures that may actually require operators to follow SOPs or receive negative responses of some types, for example, retraining.





If the assessor does not have expertise related to the coliform monitoring, it is recommended that they seek expert assistance.

The requirements for coliform sampling are in §290.109. The TCEQ also has guidance for coliform sampling in Regulatory Guidance (RG) 421.

Section 2 of the form

Figure 7 shows Section 2 of the Level 1 Assessment form. The questions in Section 2 basically list all of the elements discussed above.

Section 2 – Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
1. Were all samples collected according to a sample collection Standard Operating Procedure (SOP)? (e.g., SOP should include, at a minimum, tap sterilization, flushing, aerator removal, and the use of sterile bottles, etc.)	☐	☐	
2. Were all samples collected according to the Sample Siting Plan (SSP)?	☐	☐	
3. Were any attachments on the faucet removed?	☐	☐	
4. Was the sample tap flushed for approximately 5 minutes and until a residual disinfectant concentration of at least 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) was present in the water prior to sample collection?	☐	☐	
5. Was the sample tap treated in preparation for sample collection? (i.e., swabbed or sprayed with disinfectant, or flamed, etc.)	☐	☐	
6. Did the collector ensure that the sample was collected from a cold water tap instead of a hot water tap?	☐	☐	
7. Was a sterile laboratory-provided total coliform (TC) sample bottle used and was the sample bottle handled appropriately? (i.e., sample bottle was not exposed to contamination on the inside or its cap, etc.)	☐	☐	
8. Did the collector ensure that the sample bottle was not rinsed prior to sample collection or overfilled during sample collection?	☐	☐	
9. Were the samples delivered in a cooler not subject to contamination from other sources? (i.e., drinking water and wastewater samples should not be delivered in the same cooler, etc.)	☐	☐	
10. Were samples delivered to the laboratory within the allowable holding time?	☐	☐	
11. Were any laboratory analytical issues found?	☐	☐	

Figure 7. Section 2 on the Level 1 Assessment form.

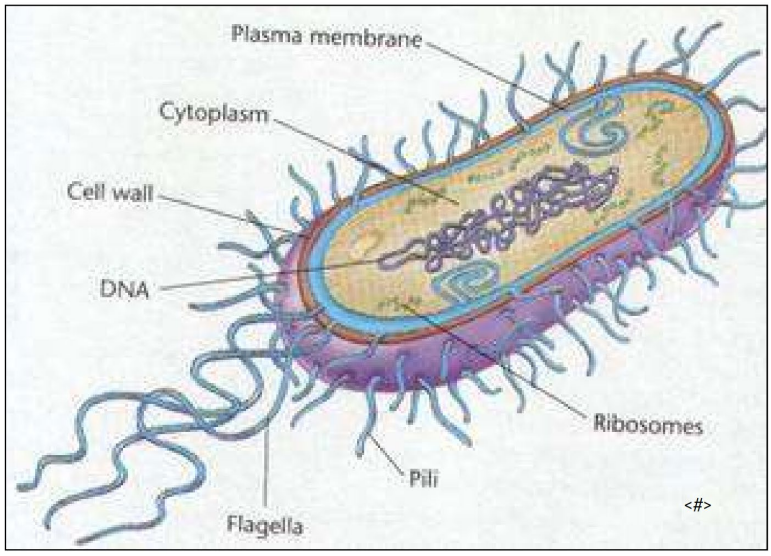


Figure 8: Cutaway of coliform bacteria

Coliform sample collection and analysis

To assess the coliform sample collection and analysis procedures, the assessor will:

- Review documents,
  - Specifically, coliform sample collection standard operating procedure (SOP), and
  - Training records, if available.
- Review data,
  - Look at chain-of-custody to see if it matches (for example, if the SOP says that samples are shipped on ice, but they arrive at the lab at 80 degrees, that would be a discrepancy), or if not,
  - Any other QA/QC data (talk to the lab, as needed),
- Review compliance data and regulatory correspondence, if present;
- Perform interviews with staff to verify that the process is followed; and
- Document any sanitary defects or additional issues in the CARP.

If the assessor does not have experience with coliform sampling, it is recommended that they seek expert assistance.

Document review: Coliform sample collection SOP

Section 2 asks about how samples were collected, and about the SOP.

NOTE:
Inadequate sampling is NOT a common cause of TC+

Research has proven that less than 2 % of positive results can be explained by inadequate sampling procedures.

Yet, 90% of the time, operators blame sampling procedures for positive samples.
This is illogical.

With adoption of the RTCR the drinking water industry should be ready at last to accept the fact that almost all the time—98% of the time—when coliform is detected,
it is because of bacterial persistence in the drinking water—
NOT because of inadequate sampling procedure.

Elements of an adequate coliform sample collection SOP

This question is intended to ensure that the assessor evaluates whether samples are collected in a way that ensures that they accurately represent the water in the distribution system.

The required elements of a coliform sample collection SOP are described below, and an example is shown after that. Appendix 1 provides more information on how to collect samples that accurately characterize the water in the mains.

It is important that samples are collected correctly; otherwise, they may be contaminated, and the results used to determine the condition of the PWS can be inaccurate.

Coliform Sample Collection SOP required elements

An SOP for collecting routine and repeat coliform sample should include these elements:

- Don't collect samples during or right before heavy flushing has been performed in the area you are taking the sample
    - Heavy flushing can stir up sediment that is not representative of distribution water.
- Don't collect samples when weather could contaminate the sample.
    - State what to do on windy or rainy days. For example, delay sample collection to the following day. Or, specify an alternate site for those conditions.
- Sample according to the schedule and sites in the Monitoring Plan
- Remove any appurtenances from the sampling tap before collecting the sample
- Have clean hands.
    - Wash hands or use sterile gloves when taking the samples.
- Disinfect the sampling tap.
    - Swabbing or spraying with a chlorine solution prior to collecting the sample.
    - If materials are all metal, flaming may be used.
- Flush the water from the sampling line before collecting the sample.
    - Make sure that enough water is flushed to make sure the water is representative of distribution system lines/pipes and is not stagnant water in the sample line or premise plumbing.
    - Ensure that the flushing is short enough that it represents local water, not water from a long distance away from the sampling tap.
    - If you base the flush time on a change in temperature, do training to make sure all sample collectors are capable of detecting small changes in water temperature, and document flush times.
- Use sterile, appropriate bottles, provided by your accredited lab, to collect sample water.
    - Check the expiration date to make sure that the bottles are not old.
- Collect disinfectant residual
    - Use the correct measurement for 'free' or 'total' chlorine.
    - Use approved methods.
    - Use appropriately calibrated instruments.
    - Write the residual on the form.
- Collect the sample.
    - Do not touch the bottle or cap, blow into the inside of the bottle or cap, place the cap on the ground or hold the bottle upside down.
    - Use a smooth, pencil-sized stream of water. Direct the stream downward to the inside of the bottle to avoid splashing.
    - Do not over- or under-fill the bottle. Fill the sample bottle to the shoulder only—100 mL line.
- Fill out the Microbial Report Forms chain-of-custody correctly. Route the sample correctly.

    - Check the correct box for "Routine," "Repeat," "Construction," or "Special."
- Don’t transport the samples in the same cooler as wastewater samples.
    - Keep the samples out of direct contact with the ice and water by using a rack or putting bottles in a sealed plastic bag.
    - Keep the samples cool but not frozen.

Using an SOP

Even if a good SOP exists, it won’t do any good if operators don’t follow it. If there is documentation that shows operators are trained to use the SOP, that is a very good sign. If they are unaware of its existence, not so much.

Some considerations in addition to those specified on the form include:

- Is the SOP current? Has current management approved the current version of the SOP? Sometimes, when managers change, the SOPs are not updated. That may be an action item from the Level 1 Assessment. If it is, note it on the follow up form.
- Do new operators get trained following the SOP? Do the procedures for training and orienting new employees include going through the actual SOP—not just demonstrating the procedure? Looking at the SOP during on-the-job training, helps operators learn the information best. Best practice is to keep a sign-off of who gets the training and when.
- Do the operators have the SOP with them on the job? Is a copy of the SOP kept in trucks or otherwise available when sampling is performed? It is easy to miss steps without a checklist or SOPs. Even pilots go through a checklist every time they get ready to fly a plane.
- Are employees evaluated on how well they follow SOPs? One of the benefits of having an SOP is that the job is always done the same and right. If staff feel that they can change the procedure randomly, the sample quality may suffer. If two operators do a procedure differently—they may get different and confusing results.
- Is there a business-process for updating SOPs? Things may change in a way that makes the SOP old and wrong. When that happens, there needs to be a way to change the SOP and get the news to everyone, not just the guy that found the problem. Is there a process where workers can make suggestions and those ideas get considered and adopted?
- Is there refresher training? If there are operators who cross train and work in two areas, if there are changes to the system, if there are changes to the SOP, or if folks are doing things wrong—refresher training can help.

These management questions don’t appear on the Level 1 Assessment form specifically. However, if a problem with the SOP is identified as a potential sanitary defect, these questions will need to be considered when developing a corrective action.

Data review: Lab QA/QC

Laboratory issues are very rarely responsible for TC+, but the assessor should double check.

PWSs either have their samples evaluated at a:

- Accredited in-house lab for PWSs with a population of 25,000 or more, or
- Accredited commercial lab.

The assessor should be able to look at the required Laboratory Approval Form in the Monitoring Plan in order to determine where the samples are analyzed. Also, the bottles provided by the lab should have identification saying where they are from. In any case, the managers or operators should be aware of the lab or labs that are used.

Note: PWSs often send coliform samples to multiple labs. In this case, the results from the lab identified in the Monitoring Plan are used for compliance.

It is recommended that the assessor talk to the lab and verify that they are accredited and have not had any issues lately. It is not usually necessary to visit the lab, a phone conversation will generally suffice. However, if there are issues, it may be necessary to visit them.

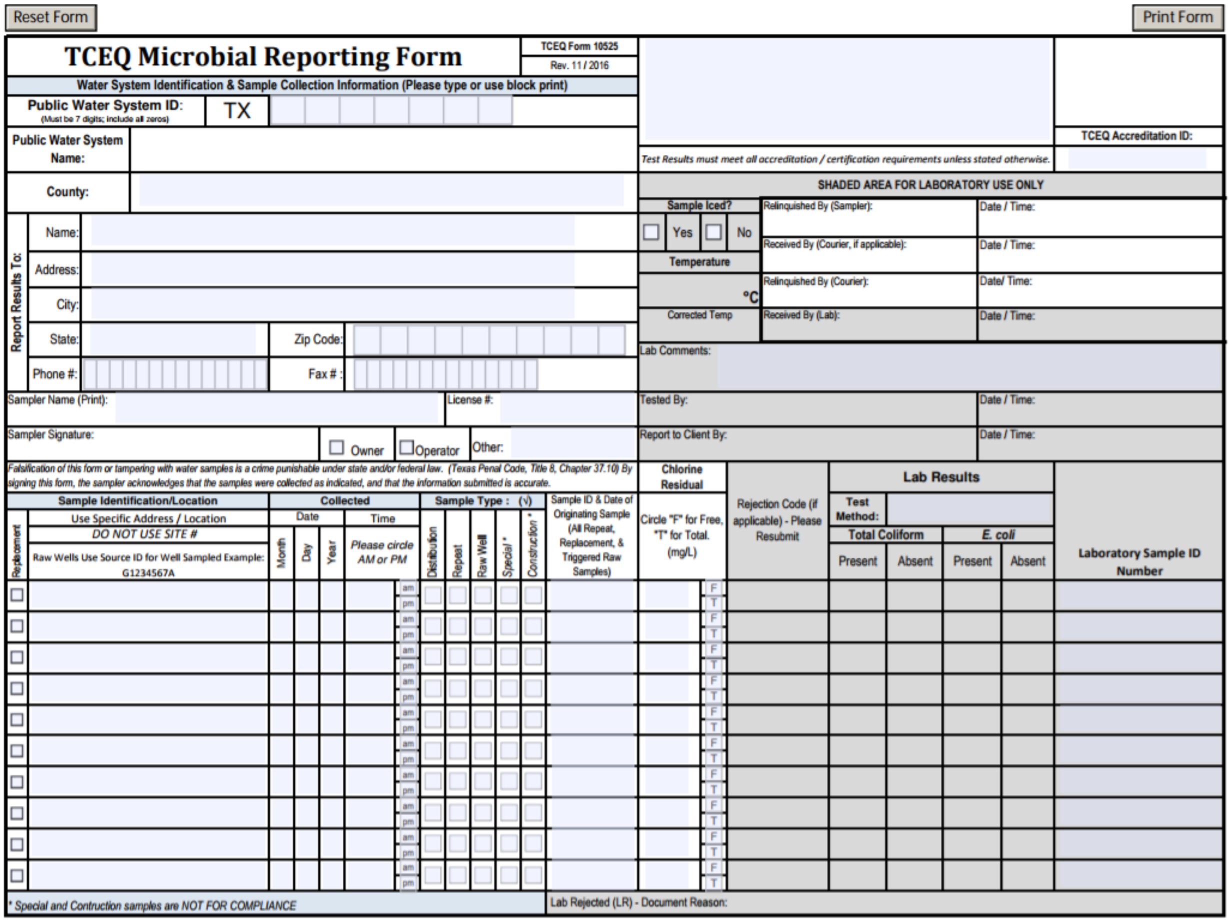
What are you looking for on the COC?

The form that PWSs use to send samples to the lab is their Chain-of-Custody documentation to ensure that no one could have tampered with samples, because they were under the control of a responsible person at all times.

Information of interest includes:

- Temperature,
- Chlorine residual,
- Collection/delivery—holding time,
- Reason for rejection, if present

The TCEQ Microbial Reporting Form is shown in Figure 9.


Reset Form | Print Form

TCEQ Microbial Reporting Form — TCEQ Form 10525, Rev. 11 / 2016

Water System Identification & Sample Collection Information (Please type or use block print)

Public Water System ID: (Must be 7 digits; include all zeros) TX

Public Water System Name:

County:

Report Results To: Name: | Address: | City: | State: | Zip Code: | Phone #: | Fax #:

Sampler Name (Print): | License #:

Sampler Signature: | ☐ Owner | ☐ Operator | Other:

Falsification of this form or tampering with water samples is a crime punishable under state and/or federal law. (Texas Penal Code, Title 8, Chapter 37.10) By signing this form, the sampler acknowledges that the samples were collected as indicated, and that the information submitted is accurate.

TCEQ Accreditation ID:

Test Results must meet all accreditation / certification requirements unless stated otherwise.

SHADED AREA FOR LABORATORY USE ONLY

Sample Iced? ☐ Yes ☐ No	Relinquished By (Sampler):	Date / Time:
Temperature	Received By (Courier, if applicable):	Date / Time:
°C	Relinquished By (Courier):	Date/ Time:
Corrected Temp	Received By (Lab):	Date / Time:

Lab Comments:

Tested By: | Date / Time:

Report to Client By: | Date / Time:

Replacement	Sample Identification/Location: Use Specific Address / Location; DO NOT USE SITE #; Raw Wells Use Source ID for Well Sampled Example: G1234567A	Collected Date: Month	Day	Year	Time: Please circle AM or PM	Sample Type (√): Distribution	Repeat	Raw Well	Special*	Construction*	Sample ID & Date of Originating Sample (All Repeat, Replacement, & Triggered Raw Samples)	Chlorine Residual: Circle "F" for Free, "T" for Total. (mg/L)	Rejection Code (if applicable) - Please Resubmit	Lab Results — Test Method: Total Coliform Present	Total Coliform Absent	E. coli Present	E. coli Absent	Laboratory Sample ID Number
☐					am / pm	☐	☐	☐	☐	☐		F / T						
☐					am / pm	☐	☐	☐	☐	☐		F / T						
☐					am / pm	☐	☐	☐	☐	☐		F / T						
☐					am / pm	☐	☐	☐	☐	☐		F / T						
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☐					am / pm	☐	☐	☐	☐	☐		F / T						
☐					am / pm	☐	☐	☐	☐	☐		F / T						

* Special and Contruction samples are NOT FOR COMPLIANCE

Lab Rejected (LR) - Document Reason:

Figure 9. TCEQ Microbial Reporting Form

On the TCEQ form, see if you can find those four elements.

Another example of a microbial submission form for the Texas Department of State Health Services for is shown in Figures 10 and 11.

TEXAS Department of State Health Services

G-19 Water Bacteriology Form Rev. JUN 2016
http://www.dshs.texas.gov/lab

*** For DSHS Use Only ***
Place DSHS Barcode Label Here

For DSHS Laboratory Use Only	Date and Time Received
	YYYY / MM / DD HH : MM (AM / PM)

Please indicate the laboratory where the sample was submitted by checking the appropriate box below:

☐ **Austin Laboratory**
Laboratory Services Section, MC-1947
P. O. Box 149347, Austin, Texas 78714-9347
Courier: 1100 W. 49th Street, Austin, Texas 78756
(888) 963-7111 x7598 or (512) 776-7598
NELAC Certificate No. T104704297
Laboratory Certifying Agency: STATE

☐ **South Texas Laboratory**
1301 S. Rangerville Road
Harlingen, TX 78552
(956) 364-8746
(956) 412-8794 Fax
NELAC Certificate No. T104704315
Laboratory Certifying Agency: STATE

Sample Collection Data

Date and Time Collected: (** REQUIRED)	**Sample Site:** (Address or other description – do not use sample site number)	
Date: MM DD YYYY (mm/dd/yyyy)		
Time: HH MM SS ☐ AM ☐ PM		
County:	**Sampler's Name:**	**Phone Number: (with area code)**
		Ext.

SYSTEM TYPE (Check one)		**WATER SOURCE** (Check water source and provide well depth, if appropriate.)
☐ Public (PWS)	☐ Dairy	☐ Ground Water *(Well)* Well Depth: _____
☐ Private (Individual)	☐ Bottled *(South Texas Laboratory ONLY)*	☐ Surface Water *(Lake, River)*
☐ School	☐ Other:_____	☐ Groundwater with Surface Water Influence

SAMPLE TYPE (Public Water Systems Only) (Check one)

☐ Routine/Distribution
☐ Construction
☐ Raw : Well ID _____
☐ Special _____
☐ Other: _____
☐ Repeat **
☐ Replacement **

** *All fields below are REQUIRED for "Repeat" or "Replacement"*
Original Lab Sample Number: _____
Date of Collection for Original Sample: MM : DD YYYY
Original Lab ID:
☐ Austin Lab ID: 48001
☐ South Texas Lab ID: 48021
☐ Other: _____

Figures 10. Top half of the DSHS microbial submission form

CHLORINE RESIDUAL
MANDATORY FOR ALL SAMPLES COLLECTED FOR TCEQ. SAMPLE SHOULD NOT BE COLLECTED IF RESIDUAL IS NOT PRESENT.
Chlorine Residual _____ mg/L ☐ Free Chlorine ☐ Total Chlorine

Sample Submitter

Public Water System ID: (** REQUIRED for PWS ONLY. 7-digits)	**Public Water System (PWS) Name:**
TX	

Send Sample Results To: (** REQUIRED)

Name:	
Address:	
City, State, Zip:	
Phone: (area code)	( )
	☐ Owner ☐ Operator ☐ Other

Results to be: ☐ Mailed ☐ Picked Up ☐ Faxed to : ( )

THE SUBMITTER WILL BE BILLED FOR ALL TESTING. There is a fee for this analysis.
DSHS is not responsible for 3rd party payment arrangements.
If you have questions about this fee, please call (512) 776-6030.

COPIES: LABORATORY (white copy) CUSTOMER (yellow copy)

**** FOR DSHS LABORATORY USE ONLY ****
SAMPLE TEMPERATURE
Is Sample Iced? ☐ YES ☐ NO If NO, then what is the temperature of the water on receipt? _____ ° C

Figure 11. The bottom half of the Texas DSHS microbial submission form

Questions in Section 2

Table 3 lists the Section 2 questions individually, with the 30 TAC citation where applicable, a description of potential sanitary defects, and a description of a potential corrective action.

Table 3. Questions on Section 2 of the Level 1 Assessment form.

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
Question 2-1. Were all samples collected according to a sample collection Standard Operating Procedure (SOP)? (e.g., SOP should include, at a minimum, tap sterilization, flushing, aerator removal, and the use of sterile bottles, etc.)	☐	☐	
2-1. Potential sanitary defect While false positives are not a sanitary defect per se, they are inaccurate data. Bad data leads to bad decisions. Focusing unnecessarily on one area may make operators miss an area that really is a problem. Poor sampling procedure can lead to false positives about once in 100 times. Even one TC+ causes extra work, so it is important that there are **zero** false positives. If samplers don't have specific instructions, they may forget a step. If all of the people who may collect samples don't do it the same way, errors may start to creep into one or more sampler's ethods. Questions 2-3 through 2-11 ask follow-up questions about the specific SOP contents in detail. **2-1. Answers** A system that is sure that samples were collected following an SOP (because they have an SOP and operators use it) would answer '**Yes**.' A system that does not have an SOP—or that has one but does not make sure it is used—would need to answer '**No**' and explain in the CARP.			
2-1. Rule requirement Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017.			
2-1. Correction options A PWS that does not have a coliform sample collection SOP should create one. This would be a good thing to note on the Follow-Up Form in the appendix of this manual. Questions 2-3 through 2-11 cover elements that should be in the SOP.			
Question 2-2. Were all samples collected according to the Sample Siting Plan (SSP)?	☐	☐	
2-2. Potential sanitary defect All samples must be collected in accordance with the schedule and sites in the PWS's Monitoring Plan attachment—the coliform Sample Siting Plan. Coliform samples should accurately reflect water quality throughout the system—for example, every pressure plane. If a system's monitoring is inadequate or not up-to-			

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
date, it may not be protective of all customers' health. The Assessor should look at the coliform Sample Siting Plan, Monitoring Plan, and distribution map. The routine samples should have been collected at the locations and schedules in the plans. Repeat samples should have been taken at the locations or according to the SOP given in the coliform Sample Siting Plan. If the coliform Sample Siting Plan was not followed, the assessor should evaluate whether that was because an adequate plan exists, but operators did not follow it, or because an adequate Sample Siting Plan was not present. **2-2. Answers** If all routine and repeat samples were collected according to the coliform Sample Siting Plan, answer '**Yes**'. If they were not, the answer is '**No**'. An answer of '**No**' should be explained in the **CARP**. For example, if no coliform Sample Siting Plan exists, the assessor should explain how the PWS plans to correct that.			
2-2. Rule requirement Every PWS is required to have a monitoring plan: "*§290.121(a) Applicability*. All public water systems shall maintain an up-to-date chemical and microbiological monitoring plan. Monitoring plans are subject to the review and approval of the executive director. A copy of the monitoring plan must be maintained at each water treatment plant and at a central location." Every PWS is required to have and follow a coliform Sample Siting Plan: "*§290.109(d)(6) Sample Siting Plan requirements*. All public water systems shall develop and complete a written Sample Siting Plan as described in this paragraph that identifies routine and repeat microbial sampling sites and a sample collection schedule as required by this subsection that are representative of water throughout the distribution system. The Sample Siting Plan shall include all groundwater sources and any associated sampling points necessary to meet the requirements of this subsection. The Sample Siting Plan shall be included as a part of the public water system's monitoring plan as described in §290.121 of this title. Sample Siting Plans shall be completed in a format specified by the executive director and are subject to review and revision by the executive director." Every PWS is required to have a distribution system map: "*§290.109(d)(6)(C)* The Sample Siting Plan shall include a distribution system map or series of maps which identifies distribution system valves and mains as described in §290.46(n)(2) of this title. The distribution system map shall also include the location of all routine microbial sample sites, water main sizes, entry point source locations, water storage facilities, and any pressure plane boundaries."			
2-2. Correction options If the coliform Sample Siting Plan is complete and accurate, but operators did not follow it, a correction option would be to retrain operators. If an adequate Sample Siting Plan was not present, one should be developed and submitted to the TCEQ. If this cannot be completed within the 30-day window, the assessor should consult with the TCEQ.			
Question 2-3. Were any attachments on the faucet removed?	☐	☐	
2-1. Potential sanitary defect Attachments on the faucet can harbor bacteria, so they should be removed from the faucet before a sample is collected. Poor sampling procedure can lead to false positives about once in 100 times. Even one TC+ causes extra work, so it is important that			

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
there are **zero** false positives. Questions 2-3 through 2-11 ask follow-up questions about the specific SOP contents in detail. **2-1. Answers** If the operator removed the attachments from the faucet, answer '**Yes'**. If the faucet did not have any attachments to remove, answer '**Yes'**. A system that does not have an SOP—or that has one but does not make sure it is used—would need to answer '**No**.' If the answer is '**No**,' it should be described in the CARP.			
2-1. Rule requirement Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017. Using an SOP for coliform sample collection is longstanding industry best practice.			
2-1. Correction options A PWS should make sure all the operators remove any attachments from taps before sampling. A PWS that does not have a coliform sample collection SOP should create one that includes this element. If this cannot be completed within the 30-day window, the assessor should consult with the TCEQ.			
Question 2-4. Was the sample tap flushed for approximately 5 minutes and until a residual disinfectant concentration of at least 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) was present in the water prior to sample collection?	☐	☐	
2-4. Potential sanitary defect If you don't flush long enough, water may be collected from the sample line—which is a dead end in and of itself. See Appendix 3 for a discussion of calculated flush time. Analyzing stagnant water from the sample line can cause a false positive. **2-4. Answers** If the operator flushed until at least the minimum residual was reached, answer '**Yes'**. If the operator did not flush until at least the minimum residual was reached, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.			
2-1. Rule requirement Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017. Using an SOP for coliform sample collection is longstanding industry best practice.			
2-1. Correction options A PWS should make sure that disinfectant residuals are continually compliant with the minimum required levels. A PWS that does not have a coliform sample collection SOP should create one that includes this element. If this cannot be completed within the 30-day window, the assessor should consult with the TCEQ.			

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
Question 2-5. Was the sample tap treated in preparation for sample collection? (i.e., swabbed or sprayed with disinfectant, or flamed, etc.)	☐	☐	
2-5. Potential sanitary defect Before collecting a sample, the tap should be disinfected. Otherwise, bacteria from the surface of the tap could contaminate the sample and cause a false positive. **2-5. Answers** If the operator disinfected the tap, answer '**Yes'**. If the operator did not flush until at least the minimum residual was reached, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.			
2-5. Rule requirement Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017. Using an SOP for coliform sample collection is longstanding industry best practice.			
2-5. Correction options A PWS should make sure that taps are disinfected before collecting samples. A PWS that does not have a coliform sample collection SOP should create one that includes this element. If the assessor believes that a coliform sample collection SOP cannot be created within the 30-day window, they should consult with the TCEQ and propose a completion date in the CARP.			
Question 2-6. Did the collector ensure that the sample was collected from a cold water tap instead of a hot water tap?	☐	☐	
2-6. Potential sanitary defect Samples should not be collected after the water goes through a hot water heater. Otherwise, bacteria from the surface of the tap could contaminate the sample and cause a false positive. **2-6. Answers** If the sample was collected from a cold-water tap, answer '**Yes'**. If, at the sample tap, there is no possibility that water could have been collected after going through a hot water heater, answer 'Yes.' For example, at a hydrant or dedicated sample station there is no chance that the water went through a hot water heater. If the operator did not flush until at least the minimum residual was reached, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.			
2-6. Rule requirement Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017. Using an SOP for coliform sample collection is longstanding industry best practice.			
2-6. Correction options The PWS's SOP should include this element. A PWS that does not have a coliform sample collection SOP should create one. If this cannot be completed within the 30-day window, the assessor should consult with the TCEQ.			

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
Question 2-7. Was a sterile laboratory-provided total coliform (TC) sample bottle used and was the sample bottle handled appropriately? (i.e., sample bottle was not exposed to contamination on the inside or its cap, etc.)	☐	☐	
2-7. Potential sanitary defect Samples should only be collected in sterile sample bottles provided by the lab. They must be handled in a sanitary, secure, appropriate manner. Unsanitary bottles or handling could contaminate a sample and cause a false positive. **2-7. Answers** If the sample was collected in a sterile bottle and handled appropriately, answer '**Yes'**. If not, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.			
2-7. Rule requirement Laboratories provide sanitary bottles with preservative as part of their requirements under the TCEQ's rules. Samples must be collected and handled appropriately, or samples will be inaccurate.			
2-7. Correction options A PWS should ensure their coliform sample collection SOP requires using sterile bottles and handling samples appropriately—and that operators follow that procedure. If the SOP cannot be revised or created within the 30-day window, the assessor should consult with the TCEQ.			
Question 2-8. Did the collector ensure that the sample bottle was not rinsed prior to sample collection or overfilled during sample collection?	☐	☐	
2-8. Potential sanitary defect The sample bottle should not be rinsed prior to collecting the samples. Otherwise, preservative may be rinsed out. **2-8. Answers** If the sample bottle was NOT rinsed, answer '**Yes'**. If the sampler rinsed the bottle, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.			
2-8. Rule requirement Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017. Using an SOP for coliform sample collection is longstanding industry best practice.			
2-8. Correction options A PWS should ensure their coliform sample collection SOP says 'don't rinse the bottle'—and that operators follow that procedure. If the SOP cannot be revised or created within the 30-day window, the assessor should consult with the TCEQ.			

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
Question 2-9. Were the samples delivered in a cooler not subject to contamination from other sources? (i.e., drinking water and wastewater samples should not be delivered in the same cooler, etc.)	☐	☐	

2-9. Potential sanitary defect

The sample bottles should be transported iced, in a cooler, but not frozen. The cooler should never be used for wastewater samples or there is a risk of contamination.

2-9. Answers

If the samples were transported correctly, answer '**Yes'**.

If the samples were subject to contamination or allowed to remain warm during transport, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.

2-9. Rule requirement

Laboratory methods require icing samples immediately after collection and delivering them at a reduced temperature, but not frozen. A lab that excepts samples at elevated temperature may risk losing their accreditation from the TCEQ's Quality Assurance Section.

Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017.

Using an SOP for coliform sample collection is longstanding industry best practice.

2-9. Correction options

A PWS should ensure their coliform sample collection SOP requires icing samples in a cooler that is not subject to contamination—and that operators follow that procedure. If the SOP cannot be revised or created within the 30-day window, the assessor should consult with the TCEQ.

Question 2-10. Were samples delivered to the laboratory within the allowable holding time?	☐	☐	

2-10. Potential sanitary defect

The sample bottle should be delivered to the laboratory promptly.

If samples are allowed to sit too long, bacteria can regrow and cause a false positive. Also, the laboratory is required to reject samples that don't meet holding time.

If the system has trouble delivering samples timely, that should be addressed.

An SOP should make it clear to operators that timely delivery is important.

2-10. Answers

If the sample was delivered on time, answer '**Yes'**.

If the a sample was not delivered on time, answer '**No'**. If the answer is '**No**,' it should be described in the **CARP**.

2-10. Rule requirement

Laboratory methods require receipt of samples within the designated time. A lab that accepts samples after holding-time exceedance may risk losing their accreditation from the TCEQ's Quality Assurance Section.

Triggering a Level 1 Assessment creates a de facto requirement that the PWS maintain and implement a coliform sample collection SOP, as per TCEQ policy on June 23, 2017.

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A
2-10. Correction options A PWS should ensure their coliform sample collection SOP requires getting the samples to the lab within the holding time—and that operators follow that procedure. If the SOP cannot be revised or created within the 30-day window, the assessor should consult with the TCEQ.			
Question 2-11. Were any laboratory analytical issues found?	☐	☐	
2-11. Potential sanitary defect Although it is unusual, the possibility that laboratory issues occurred must be considered as part of the Level 1 Assessment. In order to analyze regulatory drinking water coliform samples, labs must be 'accredited.' Accreditation involves annual audits by the TCEQ Quality Assurance Section. Accredited labs have extensive requirements for cleanliness, documentation, etc. As part of a Level 1 Assessment, if laboratory issues are suspected, the Assessor should contact the lab and request the quality assurance documentation related to the TC+ samples. **2-11. Answers** If analytical issues were found, the answer would be **'Yes**.' The issue must be documented in the **CARP**. Allegation of analytical inadequacy are taken very seriously by the TCEQ's Quality Assurance Section. Verified inadequacy can result in negative consequences, up to closing down the lab. If no analytical issues were identified, the answer is **'No**.'			
2-11. Rule requirements Laboratory accreditation under NELAC is required for analyzing coliform samples in drinking water for regulatory purposes. "§290.119(a)(1) Samples used to determine compliance with the maximum contaminant levels, samples used to determine compliance with action level, and raw groundwater source monitoring requirements of this subchapter, and samples for microbial contaminants must be analyzed by a laboratory accredited by the executive director in accordance with Chapter 25 of this title (relating to Environmental Testing Laboratory Accreditation and Certification). These samples include:… §290.119(a)(1)(E) compliance samples for microbial contaminants;…" The accreditation is defined as follows in Chapter 290. "§290.38(12) Certified laboratory--A laboratory certified by the commission to analyze water samples to determine their compliance with maximum allowable constituent levels. After June 30, 2008, laboratories must be accredited, not certified, in order to perform sample analyses previously performed by certified laboratories." The laboratory requirements are contained in 30 TAC Chapter 25: "§25.4(d) An environmental testing laboratory that provides analytical data used for a commission decision relating to the Safe Drinking Water Act must be: §25.4(d)(1) accredited according to this subchapter and Subchapter B of this chapter (relating to Environmental Testing Laboratory Accreditation); or …"			

Section 2– Coliform Sampling Protocol and Sample Collection	Yes	No	N/A

2-11. Correction options

Accredited coliform laboratories are audited every year by TCEQ's Quality Assurance Section to see if they meet NELAC accreditation standards. Failure to meet those standards can result in a lab being shut down, so labs are generally vigilant in finding and fixing potential issues on an ongoing basis.

If laboratory issues were identified, correction options include working out the issue with the current laboratory or getting a new lab. If a new lab is selected, the Monitoring Plan should be updated, showing those changes. The Monitoring Plan should be retained on-site for review by TCEQ regional staff.

In order to avoid future lab issues, a PWS can establish a protocol for taking split and blank samples and submitting them to multiple laboratories for analysis.

If any analytical issues were found and fixed, that should be described in the CARP.

Section 2 Review Questions

- ❑ Is your coliform sample collection SOP adequate?
- ❑ Do all samplers have it?
  - And follow it?
- ❑ Do you need to improve the SOP?
  - Do you need to review it with some operators?
- ❑ Do you need to look at Appendix 1 after this DAM?

TCEQ

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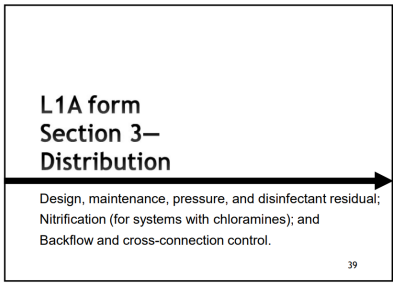
Notes

Section 3—Distribution System



Distribution facilities are critical to keep water clean all the way to the delivery point. Leaks and breaks in pipes and appurtenance can provide a pathway for pathogens to enter the distribution system.

- A **small system** with one pressure plane should evaluate all distribution facilities unless there is a compelling reason to limit the assessment to the area around the TC+.
- A **large system** must evaluate the area surrounding the TC+. This area must be large enough to capture any potential impacts from usage and pressure. For example, the pressure plane, neighborhood, or industrial area where the TC+ occurred. The basis for selecting the area assessed should be described and documented.

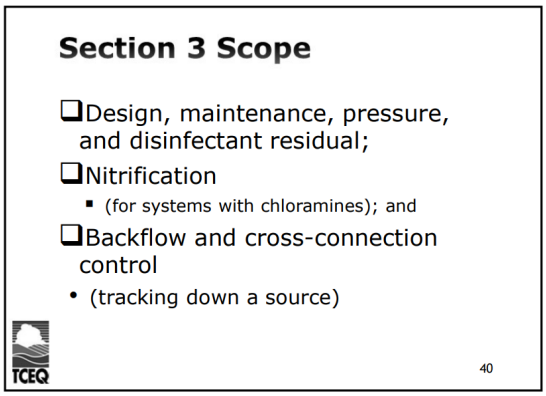
Scope

This section covers Section 3 of the Level 1 Assessment form which includes 17 questions regarding various aspects of distribution systems including:

- Design, maintenance, pressure, and disinfectant residual;
- Nitrification (for systems with chloramines); and
- Backflow.

(But not including tanks, which are discussed in Section 4)

Most of the questions in this section apply to all PWSs. The questions about nitrification only apply to PWSs that have chloramines present for some reason.

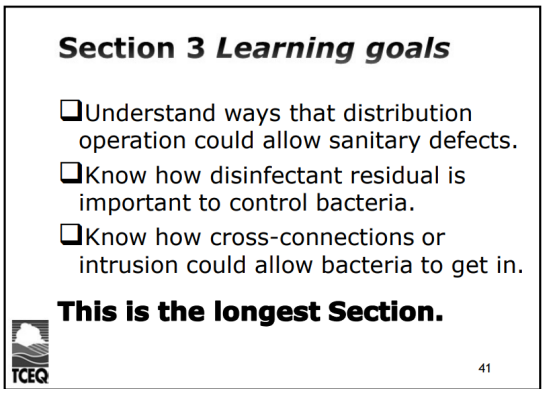


Learning goals

The learning objectives for this workshop include:

- Become familiar with Section 3 on the Level 1 Assessment form;
- Understand the impact of distribution facilities on potential pathogens:

- Know how to assess whether the distribution system has design issues;
    - Discuss how the general condition of the pipes, pumps, and other equipment—particularly valves can impact pathogen intrusion;
    - Identify any events that could cause leaks or breaks, like maintenance, construction, or repair activities;
    - Determine whether the disinfection protocols used after construction and/or repair are adequate;
    - Evaluate pressure management, and response to low-pressure events;
- Evaluate whether an adequate disinfectant residual is maintained throughout the distribution system,
    - Be able to determine whether nitrification was an issue; and
- Evaluate whether backflow or cross-connection contamination is a risk.



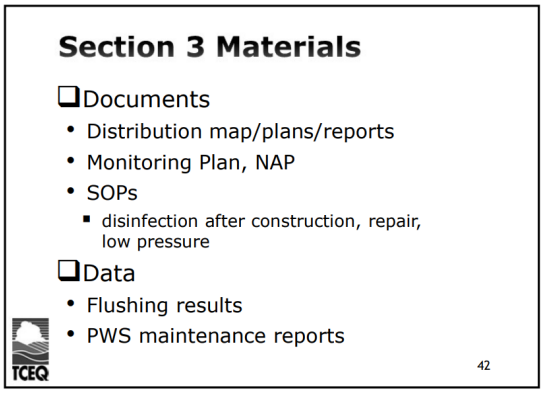
Supporting documentation

The following attachments should be discussed during the DAM

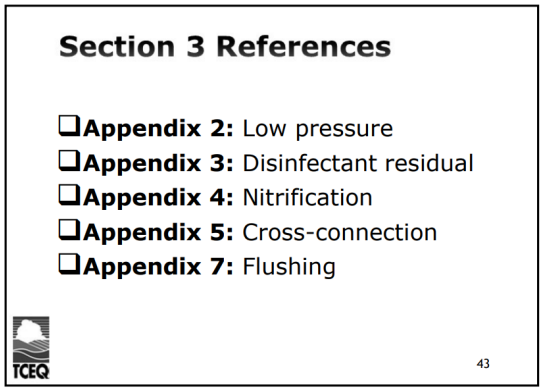
- ✓ The PWS's distribution map; and
- ✓ Flushing results (for dead-end mains, at a minimum).

The Assessor may also need to review other documents, for example:

- ✓ Plans and specifications;
- ✓ PWS maintenance reports,
- ✓ SOPs, for example, SOPs for disinfection after construction, repair, and low pressure; and
- ✓ Maintenance, construction, and repair documentation.



Appendixes 2, 3, 4, 5, and 7 will also be helpful in completing this section.



If the assessor does not have expertise with distribution systems, it is recommended that they seek expert assistance.

Section 3

Figure 12 shows Section 3 of the Level 1 Assessment form:

	Section 3 – Distribution System	Yes	No	N/A
Design, maintenance, pressure, residual	1. Are all pumps, valves, and meters maintained and operational?	☐	☐	
	2. Was there construction near the positive sample site either upstream or downstream?	☐	☐	
	3. Were any line leaks repaired and disinfected in accordance with American Water Works Association (AWWA) standards?	☐	☐	☐
	4. Were there any live leaks in the distribution system during sample collection?	☐	☐	
	5. Was there an unusual water demand around the time of the positive samples? (i.e., recent fire hydrant or valve usage, line break event, etc.)	☐	☐	
	6. Were there any residual disinfectant concentrations below 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) present in the affected area(s) or in any part of the distribution system?	☐	☐	
	7. Did the pressure drop below 20 psi anywhere in the distribution system?	☐	☐	
	8. Were required "Special Precautions" (Figure: 30 TAC §290.47(e)) procedures followed if the pressure dropped below 20 psi anywhere in the distribution system? (see instructions)	☐	☐	☐
	9. If there are any air release devices in the affected area(s), are they installed in such a manner as to preclude the possibility of submergence or possible entrance of contaminants?	☐	☐	☐
	10. Is the distribution system designed to afford effective circulation of water in the affected area(s) with a minimum of dead ends?	☐	☐	
	11. Are water distribution lines constructed and located to protect against contamination from wastewater mains and/or laterals?	☐	☐	
	12. Are all dead-end mains flushed at monthly intervals and dead-end lines and other mains in the affected area(s) flushed as needed?	☐	☐	☐
Nitrification?	13. If it was determined that nitrification occurred recently in the affected area(s) of the distribution system, did the PWS implement provisions of its Nitrification Action Plan (NAP) in the affected area(s) of the distribution system?	☐	☐	☐
	14. Was the PWS performing a temporary conversion to free chlorine in the affected area(s) of the distribution system during the time the total coliform-positive sample(s) was/were collected?	☐	☐	
Backflow?	15. Were all backflow prevention assemblies tested and determined to be functioning at the positive sample site, as applicable?	☐	☐	☐
	16. Was it determined that the distribution water was impacted by any other backflow-event?	☐	☐	
	17. Are appropriate backflow prevention assemblies and/or air gap installed at every connection with a potential health hazard, and tested and determined to be functioning, as applicable?	☐	☐	☐

Figure 12. Section 3—Distribution on the Level 1 Assessment form.

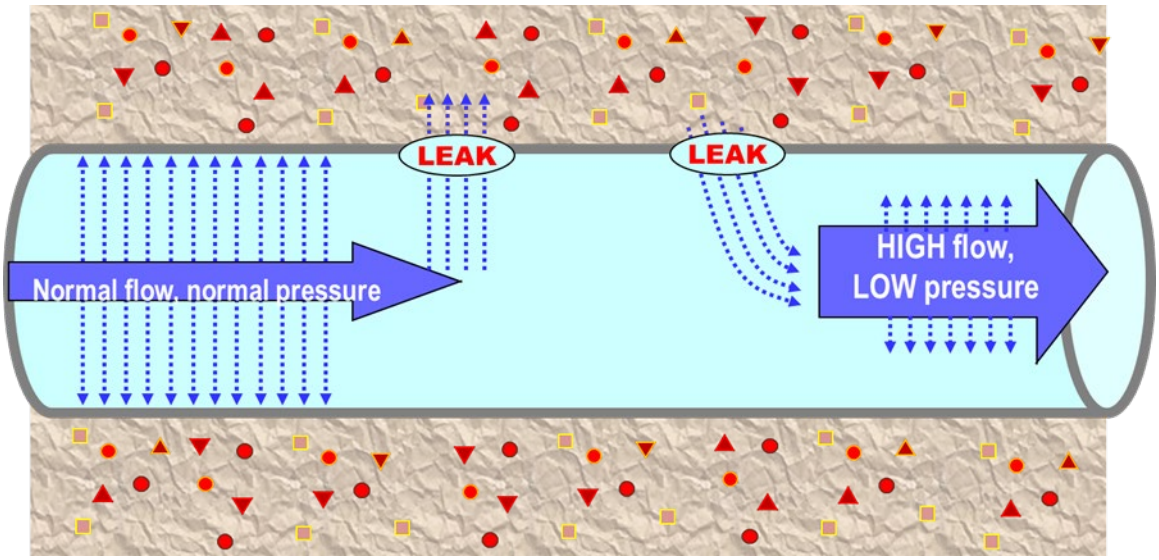


Figure 13. If it leaks out, it can leak in!

Assessment process summary: Distribution

To assess distribution, the assessor will:

- For all systems, assess
  - design,
  - maintenance,
  - pressure, and
  - disinfectant residuals;
- For systems with chloramines, assess whether nitrification occurred; and
- For all systems, assess backflow and cross-connection control.

The general process will follow the same flow as the assessment for coliform sites and coliform SOPs:

- Review documentation,
- Review data,
- Verify data and documentation as well as possible, and
- Document any sanitary defects or additional issues in the CARP.

Details for the process for the various components, and sections of the Level 1 Assessment form, are provided in detail below.

Distribution design: Assessment-process summary

The TCEQ rules in §290.44 describe the minimum design standards for distribution facilities, for example separation distances between sewer lines and drinking water lines. §290.44(f) describes requirements for post-disinfection related to construction activities.

- Review documents like:
  - Plans or maps of distribution facilities in the area of the TC+,

    - Any ordinances or construction guidelines provided to developers regarding pipe separation distances, if present;
- Review compliance data and regulatory correspondence,
    - CCI reports may document design violations and/or additional issues,
    - More likely, design violations would be documented in regulatory correspondence with the TCEQ Water Supply Division (or other plan review authority),
- Interview staff with historical knowledge of pipe installation, including operators, engineers, or managers to verify or clarify review findings, and
- Document any sanitary defects or additional issues in the CARP.

Some well-documented sanitary defects that have been found to be both potential and actual pathways to pathogens include:

- Sewer and water pipes running in the same trench;
- Faulty pipe underlayment leading to cracked and leaking pipes;
- Incorrectly vented pipes;
- Incorrectly sized in-line booster pumps;
- Bad pipe-to-pipe connection;
- Etc.

Distribution maintenance: Assessment-process summary

If you don't change your oil, your car will break.

Maintenance is a fundamental need for all physical facilities. Distribution pipes and equipment are often out of sight, or overlooked, so poor maintenance is a frequent problem at PWSs.

During a Level 1 Assessment, the assessor should evaluate whether the facilities are maintained well. If there are indications of poor maintenance, there may be an underlying problem with the system that may be fixin' to cause even bigger problems than TC+.

The assessor will:

- Review documents like:
    - Plans or maps of distribution facilities in the area of the TC+,
    - Any ordinances or construction guidelines provided to developers regarding pipe separation distances, if present;
    - SOPs, for example, SOPs for disinfection after construction, repair, and low pressure;
- Review operational data, like:
    - Pressure data,
    - Complaint data,
    - Flushing data,
    - Disinfectant residual data,
- Review compliance data and regulatory correspondence,
    - CCI reports may document design violations and/or additional issues,

    - More likely, design violations would be documented in regulatory correspondence with the TCEQ Water Supply Division (or other plan review authority),
- Interview staff with historical knowledge of pipe installation, including operators, engineers, or managers, and
- Document any sanitary defects or additional issues in the CARP.

If the assessor does not have experience with distribution systems, it is recommended that they seek expert assistance.

Figure 14. When pipes are stored outside, they are vulnerable to contamination

Disinfection after repairs and construction

The TCEQ requires that PWSs follow AWWA standards after repair or construction. The following description of disinfecting construction/repair sites does not replace AWWA standards, but serves as a overview. Greater detail is available in Appendix 3, and the AWWA standards themselves are available in AWWA C651-14 "**DISINFECTING WATER MAINS**" at:

www.awwa.org/store/productdetail.aspx?productid=45320336

Generally speaking, your disinfection protocol should ensure that you hold a 25 mg/L residual for 24 hours (not less than 10 mg/L after the 24 hour hold). A continuous feed of chlorine should be used.

Under emergency conditions, the 'slug method' may be used. In the slug method, you must ensure that a 'slug' of water with 100 mg/L contacts each portion of pipe for at least 3 hours. If the concentration drops, decrease flow or add more chlorine. If it goes below 50 mg/L, start over.

Whatever method is used, monitor and record the chlorine residual and flow (if applicable).

Liquid hypochlorite or gas chlorine are preferred. Granular hypochlorite can be used for the slug method. If it is a very short pipe, pellets may be ok.

Operate related valves and hydrants as the chlorinated water flows past fittings and valves, to disinfect appurtenances and pipe branches.

Be careful how you dispose of the super-chlorinated water. If you are going to put it in a ditch or gutter that runs into a stream, you must dechlorinate it. If you put it in a sewer, talk to the wastewater folks first.

Before returning the pipe to service, you need to collect at least one coliform sample every 1,000 feet of pipe and get results that have zero bacteria (absence of coliform bacteria). If you can't do that, and you need to get the water on before you get the clean samples, you must issue a boil water notice.

Distribution pressure maintenance: Assessment-process summary

Pressure must be maintained throughout the distribution system.

- A **small system** with one pressure plane should evaluate pressure and usage throughout the entire distribution system.
- A **large system** must evaluate pressure in the area surrounding the TC+. This area must be large enough to capture any potential impacts from usage and pressure. For example, the pressure plane, neighborhood, or industrial area where the TC+ occurred.

The minimum allowable normal operating pressure in distribution is 35 psi. If increased usage for fire flow occurs, the pressure must never drop below 20 psi. Pressure drops below 20 psi may require a boil water notice (BWN). Additionally, the PWS must document the cause of all pressure drops below 35 psi.

Maintaining pressure in the distribution system is important because it moves the water to its intended destination, and also because as long as the pressure inside the pipe is higher than the pressure outside the pipe, water will tend to flow from the inside-to-outside through any pinholes or leaks. When pressures drop below 20 psi, the distribution system is more susceptible to contamination from backflow and backpressure events.

The distribution rules in §290.44, the capacity rules in §290.45, and the operation requirements in §290.46(r) and §290.47(e) all describe the pressure requirements for PWSs. §290.47(e) describes when a PWS must disinfect a low-pressure area, and/or issue a boil water notice for low pressure. PWSs must keep a record of pressure complaints per §290.46(f)(3)(A)(iii).

Although the regulations do not have specific frequencies and locations for required pressure measurement, a PWs must be able to measure pressure in order to measure and determine compliance with the minimum pressure requirements.

If any low pressure event or unusual demand occurred, you must describe it in CARP section at the end of the Level 1 Assessment form. If any pressure event was a concern, you must submit documentation of pressure measurements.

If a high pressure condition of some sort contributed to a TC+, that will probably be described under Section I, regarding repair.

Leakage

As the saying goes: ***"If it leaks out, it can leak in!"***

The first steps to assess the overall 'leakiness' of the system are:

- Interview operators, and
- Review water loss data.

Operators have first-hand experience of repairing leaks, and may be able to provide a sense of how frequent they are, and why they occur. For example, in one case the operator was able to explain that leaks were prevalent because pipes were installed in karstic areas with improper bedding.

Water loss data may be available, especially for large systems that have to report to Texas Water Development Board. At small systems that sell water, it should at least be possible to compare the amount of water produced to the amount billed. It will be most difficult to assess water loss at a very small noncommunity PWS that does not measure water used, since they don't have billing records.

Remember—leaks can be present, but unseen. For example, in the karst example, most water leaks flow downward through the rock, not upward into people's lawns.

Distribution disinfectant residual: Assessment-process summary

Some questions to consider include:

- Do sites represent the distribution system as required by §290.110(c)(4)?
  - Do sites represent all pressure planes?
  - Do sites represent major customers and critical infrastructure such as water served to health facilities
  - Have sites been updated to reflect PWS growth (or shrinkage)?
- Are samples collected at the required schedule (daily or weekly) per §290.110(c)(4)?
- Are multiple samples collected (daily/weekly) if needed to represent the entire distribution system (for example, samples in each pressure plane daily/weekly)

Flushing

Flushing results can provide a clue to sites with excessive water age? (e.g. heavy sediment)

Review the PWS's records for flushing, including dead-end main flushing, for the most recent two months through present. If customer complaints that made it necessary for PWS staff to perform flushing increased recently, it may indicate a water age issue. If the data indicates that it has been taking longer than normal to reach an adequate residual when flushing, water age may be an issue.

Appendix 7 provides example procedures for dead-end main flushing programs.

Review the dead-end main flushing program, valve exercise program, and water loss audit and update them if needed. Review customer complaints to identify trends and possible corrective measures.

Consider distribution system modifications to lessen water age. For example: looping distribution lines and eliminating dead ends. If construction is needed, the Assessor should consult with the TCEQ.

If a dead-end main flushing program exception is needed, the Assessor should consult with the TCEQ.

Nitrification: Assessment-process summary

Appendix 4 provides additional information on nitrification.

Questions related to nitrification only apply to PWSs that use or have chloramines present. This issue does not generally apply to systems that only have free chlorine present.

However, systems that think they have free chlorine may be surprised to find that they don't—if naturally occurring ammonia is in their source. Wells in Texas have been found to have as much as 5 mg/L free available ammonia in the Gulf Coast and Carrizo-Wilcox aquifers. Sources subject to contamination from wastewater, especially karstic aquifers, have been found to have 1 to 2 mg/L of ammonia.

If the assessor does not have experience with chloramines, it is recommended that they seek expert assistance.

A PWS that has problems holding their free chlorine residual should check the ammonia level in their source water.

Backflow: Assessment-process summary

Appendix 5 provides additional information about cross-connection control and backflow prevention.

The questions in Section 3 about cross connections apply to all PWSs. Cross-connections and backflow events are the biggest cause of drinking water contamination in Texas, based on the CDC documentation that the two biggest causes nationwide are: inadequately disinfected groundwater, and cross connection/backflow.

If the assessor does not have experience with cross-connection control, it is recommended that they seek expert assistance.

Questions in Section 3 of the Level 1 Assessment form

This section includes 17 questions related to distribution system design and operation.

Table 4 lists these questions individually, with the 30 TAC Subchapter D citation, where applicable, a description of potential sanitary defects, and a description of a potential corrective action.

Table 4. Questions on Section 3 of the Level 1 Assessment form

Questions in Section 3: Design, maintenance, pressure, and residual

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
Question 3-1. Are all pumps, valves, and meters maintained and operational?	☐	☐	
3-1. Potential sanitary defect Broken or poorly maintained equipment can cause TC+ by allowing contaminants to enter, or by harboring colonies of re-growing bacteria. The most common issues is poorly-maintained valves. Don't just say 'Yes' based on an assumption that all PWSs maintain their valves—that is not true. Find out. Assess whether inoperable or poorly maintained equipment is present, and may have led to contamination in the area near the TC+. Evaluate the PWS's maintenance procedures to see if needed maintenance is performed in a timely manner. For example, determine whether the system has a valve maintenance program to periodically exercise all valves, make sure that they will turn smoothly, and verify they are set correctly. **3-1. Answers** If all of the valves, particularly, are exercised annually or can otherwise be demonstrated to be in good repair, the answer is '**Yes**.' If not, the answer is '**No**.' If there is a problem with some distribution facilities that could be causing stagnation or contamination, the Assessor should describe that in the **CARP**. If the status of equipment is an issue—for example, if needed repairs have not been done—the CARP should describe that.			
3-1. Rule requirements Good maintenance is a rule requirement: "§290.46(m)(4) All water treatment units, storage and pressure maintenance facilities, distribution system lines, and related appurtenances shall be maintained in a watertight condition and be free of excessive solids." "§290.46(m)(6) Pumps, motors, valves, and other mechanical devices shall be maintained in good working condition."			
3-1. Correction options Whether or not valve maintenance is routinely performed, it is a good idea to perform a 'valve sweep' after a TC+. • First, locate the nearby valves; • Then, go to each valve and make sure it can turn; • Set the valve correctly; and • Document that it was done, and what setting is 'correct'. If a valve won't turn, or breaks when the attempt is made to turn it, maintenance can be scheduled. If a valve turns freely—it may or may not be in good repair. If any doubt exists, isolate the valve, turn on one downstream hydrant, and ensure that closing the valve stops the water from flowing out the hydrant. If the status of equipment is an issue—for example, if valves have been paved over or are stuck closed—the CARP should describe that. If additional time is needed for engineering and construction, the Assessor should consult with TCEQ. Best practice is to exercise valves at least annually (NAS, 2006)			

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
Question 3-2. Was there construction near the positive sample site(s) either upstream or downstream?	☐	☐	

3-2. Potential sanitary defect

During construction, pipes are vulnerable to outside contamination. Consider whether construction was happening near any of the sites where TC+ was found.

If construction occurred, review any documentation, such as sampling results and records of how pipe was stored prior to construction. Consider whether the construction could have led to dirt or dirty water getting into the distribution pipes.

If it is determined that the manner in which construction was performed led to TC+, immediately re-disinfecting the contaminated area would be a correction option.

If the construction process did not adequately protect the water quality, those procedures would need to be corrected. The assessor should consult with the TCEQ.

Some PWSs have different groups who perform work in distribution. For example, PWS staff may do unplanned emergency work, but contractors may be used for planned construction. Therefore, the assessor should ensure that the individuals with actual knowledge of the work are interviewed, not other staff who may be making assumptions.

In order to evaluate whether construction was upstream or downstream, the assessor should consider the hydraulic forces present at the time of the TC+s. Under different usage conditions, water can flow either way in most pipes, except for the largest mains.

3-2. Answers

If no construction or repair occurred, the answer is '**No**.'

If construction or repair occurred, the answer is '**Yes**.' If it is determined that construction or repair caused the TC+, that should be described in the **CARP**. Also, if corrective action has been taken, that should also be described.

3-2. Rule requirement

§290.44(f)(3) and §290.46(g) rules for post construction and repair disinfection are shown under the next question. §290.46(m) requires that PWSs maintain the distribution system in watertight condition.

3-2. Correction options

If any area of construction is believed to be contaminated, it should be re-disinfected and flushed. The PWS should review their oversight of construction practice to ensure this does not happen again.

Question 3-3. Were any line leaks repaired and disinfected in accordance with American Water Works Association (AWWA) standards?	☐	☐	☐

3-3. Potential sanitary defect

Any time pipes are open for repair, the water is vulnerable—a clear pathway for pathogens is present. If there was repair or construction, was the area properly disinfected before being placed back into service?

The assessor should evaluate the procedures for construction and post-construction disinfection procedures—particularly for isolating construction areas and disinfecting after construction—and make sure that they are adequately protective and are consistent with AWWA standards.

If multiple groups—for example, contractors—perform construction and/or repair, the

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A

assessor should interview representatives of those groups and/or review their documentation and SOPs.

3-3. Answers

If there was no repair or construction (planned or unplanned), the answer is **'N/A**.'

If there was either planned or unplanned work, and the area was disinfected in accordance with AWWA standards, the answer is **'Yes**.'

If there was any repair or construction (planned or unplanned), and the area was ***not*** disinfected according to AWWA standards, the answer is '**No**.'

If there was any repair or construction that could have led to TC+, it should be described in the **CARP**.

3-3. Rule requirement

The rules require that PWSs implement disinfection in accordance with AWWA standards.

"§290.44(f)(3) New mains shall be thoroughly disinfected in accordance with AWWA Standard C651 and then flushed and sampled before being placed in service. Samples shall be collected for microbiological analysis to check the effectiveness of the disinfection procedure. Sampling shall be repeated if contamination persists. A minimum of one sample for each 1,000 feet of completed waterline will be required or at the next available sampling point beyond 1,000 feet as designated by the design engineer."

"§290.46(g) Disinfection of new or repaired facilities. Disinfection by or under the direction of water system personnel must be performed when repairs are made to existing facilities and before new facilities are placed into service. Disinfection must be performed in accordance with American Water Works Association (AWWA) requirements and water samples must be submitted to a laboratory approved by the executive director. The sample results must indicate that the facility is free of microbiological contamination before it is placed into service. When it is necessary to return repaired mains to service as rapidly as possible, doses may be increased to 500 mg/L and the contact time reduced to 1/2 hour."

3-3. Correction options

If any area is believed to have been contaminated, it should be re-disinfected and flushed. The PWS should review their oversight of construction practice to ensure this does not happen again.

Question 3-4. Were there any live leaks in the distribution system during sample collection?	☐	☐	

3-4. Potential sanitary defect

Leaks are a high risk because they provide a source of pathogens during low pressure spikes. If high usage occurs in a system with persistent leaks, it will cause a high risk of pathogen intrusion. Not all leaks are visible—some water leaks into geographic features like karst, or occurs in unpopulated areas.

Assess whether leaks in the distribution system were 'live' during sample collection.

Many community PWSs are required to report their water loss to the Texas Water Development Board. The assessor should review these and other documents to verify whether excessive leakage was occurring.

At a minimum, if billing records are present, it should be possible to compare well production records with water sold to get an estimate of leakage rates.

3-4. Answers

If there were no leaks, check '**No**.'

If so, check '**Yes**.' The **CARP** should describe any leakage that could have impacted the distribution system.

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
3-4. Rule requirement The rules under §290.46(m) require that PWSs maintain the distribution system in watertight condition. The TCEQ rules require limited hydrostatic leakage rate under §290.44(a)(5). Additionally, leaks cause lost revenue that could be used for system maintenance and operation.			
3-4. Recommendations It is highly recommended that PWSs be aware of leaks in their system. Leaks can impact the whole distribution system if they are letting contaminants come in continuously OR intermittently. If persistent leaks are present, and can lead to widespread contamination. Leakage is like a litmus test for infrastructure adequacy. As infrastructure degrades, leaks increase. If this goes on for any extended time, it is certain to lead to both sanitary defects and compliance problems. Because, science. The practical solution is for a PWS to address leaks before they get too big—it is easier to fix a little leak now than a big leak later. If outages occur, the system must consult with the TCEQ about boil water notices and follow-up sampling. When outages occur, the system is at zero pressure. Any external contaminant can flow in through little imperfection… and as water leaks out due to gravity, contaminants WILL get in.			
Question 3-5. Was there an unusual water demand around the time of the positive samples? (i.e., recent fire hydrant or valve usage, line break event, etc.)	☐	☐	
3-5. Potential sanitary defect Unusually high demand can suck contaminants into the distribution pipes through leaks, unprotected cross connections, etc. It can even cause line breaks or cracks resulting from rapid changes in pressure or water hammer. Review any pressure data for the area surrounding the TC+ to help determine whether pressure was continuously maintained in that area. Determine whether the increased demand, pressure fluctuations or water hammer could have led to a TC+. The most common reasons for high usage are main breaks and firefighting. Other reasons could be the accidental draining of a storage tank because a valve is not closed or pump is not turned off, some customer is filling their pool, or other unique circumstances. If unusual demand caused the TC+, the Assessor should consider how the system or operational procedures could be modified to prevent the situation in the future. If construction is required in order to repair pressure-maintenance equipment, the Assessor should consult with the TCEQ. **3-5. Answers** If no unusual demand occurred in the timeframe of the TC+, the answer would be '**No**.' If unusual demand occurred for any known or unknown reason, the answer is **'Yes**.' Any unusual demand should be described in the **CARP**, especially if it was clear that it led to the TC+s.			
3-5. Rule requirement The rules require that PWSs maintain pressure during high usage. *"§290.44(d) Minimum pressure requirement*. The system must be designed to maintain a minimum pressure of 35 psi at all points within the distribution network at flow rates of at least 1.5 gallons per minute per connection. When the system is intended to provide fire-fighting capability, it must also be designed to maintain a minimum			

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
pressure of 20 psi under combined fire and drinking water flow conditions. The distribution system of public water systems that are also affected utilities must be designed to meet the requirements of §290.45(h) of this title (relating to Minimum Water System Capacity Requirements)." There is no circumstance allowing a degradation of water quality due to high demand—water quality standards apply continuously, at all times, under all circumstances.			
3-5. Correction options If unusual demand contributed, or could contribute, to water quality degradation, the PWS should make sure it does not happen again. For example, by analyzing the hydraulics of the distribution system and working with the fire department to make sure isolation valves are set correctly when hydrants are to be used.			
Question 3-6. Were there any residual disinfectant concentrations below 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) present in the affected area(s) or in any part of the distribution system?	☐	☐	
3-6. Potential sanitary defect The presence of disinfectant residual is one of the major barriers to pathogens in distribution systems. If required disinfectant residual samples were not collected, low-residual, high-risk areas may exist without detection causing sanitary defects. The assessor should review the recent disinfectant residual results, focusing on results near the TC+s. However, since residual maintenance is a system-wide concern, the assessor should review all results. ***Note:*** This data is a ***required attachment*** to the Level 1 Assessment submittal.			
3-6. Answers If no low residuals were noted anywhere in the system, the answer is '**No'**. If low residuals occurred, the answer is '**Yes**,' and this answer should be described in the **CARP**. The impacted area, level of residual, and responses by the system should be documented. If this data is not available, that may be a violation of TCEQ rules. In that case, the **CARP** should describe how changes will be made to comply with the rules. (Note—this information is also included in question 4-12.)			
3-6. Rule requirement All Texas PWSs must maintain disinfectant residuals at all locations, at all times: "*§290.110(a) Applicability.* All public water systems shall properly disinfect water before it is distributed to any customer and shall maintain acceptable disinfectant residuals within the distribution system. *§290.110(b)(1)* The disinfection process used by public water systems must ensure that water has been adequately disinfected before it enters the distribution system. *§290.110(b)(4)* The residual disinfectant concentration in the water within the distribution system shall be at least 0.2 mg/L free chlorine or 0.5 mg/L chloramine (measured as total chlorine)."			
3-6. Correction options Appendix 3B discusses residual maintenance in greater detail.			

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
Question 3-7. Did the pressure drop below 20 psi anywhere in the distribution system?	☐	☐	

3-7. Potential sanitary defect

Pressure lower than 20 psi is of concern. Intrusion of contamination can occur even when pressure drops briefly. This is especially true if any leaks are present, and they almost always are, at least small leaks.

There are many problems that can lead to problems with low pressure. One common issue is valve settings being incorrect. The most probable immediate corrective action is to check all the valves in the area of the TC+.

A water outage indicates that the pressure in the affected area is atmospheric—in other words, zero psig (pounds-per-square-inch, gauge). That is a situation with grave concerns.

3-7. Answers

If pressure did not drop below 20 psi, the answer is '**No**.'

If pressure dropped below 20 psi, the answer is '**Yes**,' and the situation should be explained in the **CARP**.

3-7. Rule requirement

The rules under "§290.44(d) and §290.46(r) require that a pressure of at least 35 psi be maintained during normal conditions. If a pressure of less than 35 psi is detected during normal operating conditions, it is a violation:

"§290.44(d) Minimum pressure requirement. The system must be designed to maintain a minimum pressure of 35 psi at all points within the distribution network at flow rates of at least 1.5 gallons per minute per connection. When the system is intended to provide fire fighting capability, it must also be designed to maintain a minimum pressure of 20 psi under combined fire and drinking water flow conditions. The distribution system of public water systems that are also affected utilities must be designed to meet the requirements of §290.45(h) of this title (relating to Minimum Water System Capacity Requirements)."

"§290.46(r) Minimum pressures. All public water systems shall be operated to provide a minimum pressure of 35 psi throughout the distribution system under normal operating conditions. The system shall also be operated to maintain a minimum pressure of 20 psi during emergencies such as fire fighting. As soon as safe and practicable following the occurrence of a natural disaster, a public water system that is an affected utility shall maintain a minimum of 35 psi throughout the distribution system during an extended power outage."

3-7. Correction options

The correction would be different depending on what caused the low pressure.

DSIP Contamination can occur even with positive pressure in the

Question 3-8. Were required "Special Precautions" (Figure: 30 TAC §290.47(e)) procedures followed if the pressure dropped below 20 psi anywhere in the distribution system? (see instructions)	☐	☐	☐

3-8. Potential sanitary defect

If pressure dropped below 20 psi, the flowchart in 290.47(e) must be followed. That flow chart is shown in Appendix 2.

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
If the PWS had to follow the flowchart, the assessor should review all of the documentation associated with that, including bacteriological data. **3-8. Answers** If pressure did not drop below 20 psi, the answer is '**N/A**'. If pressure dropped below 20 psi, and the flowchart was followed, the answer is '**Yes**.' This will need to be mentioned in the CARP. If pressure dropped below 20 psi and the flowchart was NOT followed, the answer is '**No**.' this should be fully documented in the **CARP**, and the CARP should describe how the PWS will ensure that this does not happen again. If this data is not available, that may be a violation of TCEQ rules.			
3-8. Rule requirement The TCEQ rules require that a PWS perform follow up actions in the case of any pressure drop. "§290.46(q) Special precautions. Special precautions must be instituted by the water system owner or responsible official in the event of low distribution pressures (below 20 pounds per square inch (psi)), water outages, microbiological samples found to contain *Escherichia coli* or fecal coliform organisms, failure to maintain adequate chlorine residuals, elevated finished water turbidity levels, or other conditions which indicate that the potability of the drinking water supply has been compromised. §290.46(q)(1) Boil water notifications must be issued to the customers within 24 hours using the prescribed notification format as specified in §290.47(c) of this title. A copy of this notice shall be provided to the executive director. Bilingual notification may be appropriate based upon local demographics. Once the boil water notification is no longer in effect, the customers must be notified in a manner similar to the original notice. §290.46(q)(2) The flowchart found in §290.47(e) of this title shall be used to determine if a boil water notification must be issued in the event of a loss of distribution system pressure. If a boil water notice is issued under this section, it shall remain in effect until water distribution pressures in excess of 20 psi can consistently be maintained, a minimum of 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) is present throughout the system, and water samples collected for microbiological analysis are found negative for coliform organisms. §290.46(q)(3) A boil water notification shall be issued if the turbidity of the finished water produced by a surface water treatment plant exceeds 5.0 NTU. The boil water notice shall remain in effect until the water entering the distribution system has a turbidity level below 1.0 NTU, the distribution system has been thoroughly flushed, a minimum of 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) is present throughout the system, and water samples collected for microbiological analysis are found negative for coliform organisms. §290.46(q)(4) Other protective measures may be required at the discretion of the executive director."			
3-8. Correction options See Appendix 3 for the Special Precautions flow chart of §290.47(e).			
Question 3-9. If there are any air release devices in the affected area(s), are they installed in such a manner as to preclude the possibility of submergence or possible entrance of contaminants?	☐	☐	☐
3-9. Potential sanitary defect Consider whether inundation, submergence, or other contamination of any air release			

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
devices could have occurred. Review recent investigation reports and TCEQ compliance documentation, this may be noted as a violation. **3-9. Answers** If no air release devices exist in the distribution system, the answer is '**N/A'**. If there are air-release devices, but they are installed in a manner so as to preclude the possibility of contamination, the answer is '**Yes**.' If there are air-release devices that could be subject to contamination, the answer is '**No'** and the situation should be described in the **CARP**, along with plans to correct that situation.			
3-9. Rule requirement Air release device rules exist under §290.41(c)(3)(Q) §290.42(b)(7) §290.42(c)(7) §290.42(d)(2)(F). This question specifically references the distribution requirement of §290.44(d)(1): "§290.44(d)(1) Air release devices shall be installed in the distribution system at all points where topography or other factors may create air locks in the lines. Air release devices shall be installed in such a manner as to preclude the possibility of submergence or possible entrance of contaminants. In this respect, all openings to the atmosphere shall be covered with 16-mesh or finer, corrosion-resistant screening material or an acceptable equivalent."			
3-9. Correction options Failure to adequately install, locate, and maintain air release devices may be noted in CCI reports as a violation. The assessor should consult with the TCEQ regarding planned relocation or replacement of air-release valves. The PWS should notify TCEQ of the project overview, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted.			
Question 3-10. Is the distribution system designed to afford effective circulation of water in the affected area(s) with a minimum of dead ends?	☐	☐	
3-10. Potential sanitary defect Dead-ends are called 'dead' because the water can sit there for a long time and get really bad. When that happens, bacteria can persist and regrow, thus causing a sanitary defect and lots of complaints. Any area of the distribution where water does not circulate is a concern, including physical dead-ends and hydraulic dead-ends. Assess whether numerous dead ends are present, especially in the affected areas. If so, are there ongoing complaints? Low residuals? Persistence of sediment on flushing reports? The assessor should consider whether a municipality implements ordinances to make sure that new construction is designed to limit creation of additional dead ends. Review recent investigation reports and TCEQ compliance documentation, this may be noted as a violation. **3-10. Answers** If the distribution system is designed to minimize dead ends and limit stagnation of water through effective circulation, the answer is '**Yes'**. If there are excessive dead ends and no plan to 'loop' those, the answer is '**No**' and situation should be documented in the **CARP**.			

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A

3-10. Rule requirement

The rules under §290.44(d)(6) require:

"*§290.44(d)(6)* The system shall be designed to afford effective circulation of water with a minimum of dead ends.
All dead-end mains shall be provided with acceptable flush valves and discharge piping.
All dead-end lines less than two inches in diameter will not require flush valves if they end at a customer service.
Where dead ends are necessary as a stage in the growth of the system, they shall be located and arranged to ultimately connect the ends to provide circulation."

3-10. Correction options

If there is an issue with how the distribution system is designed that could allow degradation of water quality, the assessor should consult with TCEQ about plans to correct that sanitary defect and compliance issue. The assessor should consult with the TCEQ regarding planned corrections. The PWS should notify TCEQ of any proposed project, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted.

Question 3-11. Are water distribution lines constructed and located to protect against contamination from wastewater mains and/or laterals?	☐	☐	

3-11. Potential sanitary defect

Consider whether broken or poorly maintained equipment could have caused the TC+. The most common issues occur with valves that are not adequately maintained. I.1. Are distribution facilities built to protect from sewage? TCEQ rules include requirements that sewer lines be separated from drinking water lines, and many other detailed rules exist to protect from contamination.

Review the distribution design records. Consider whether a risky area is near the TC+. For example, if there are areas where sewage pipes and water pipes are in the same trench, is that near the location of the TC+?

Review TCEQ compliance documentation. Previous correspondence from the TCEQ may identify distribution facility design and construction issues.

3-11. Answers

If only water service is present, and no wastewater collection lines are present, the answer is '**N/A**.'

If it is certain that pipes were installed in separate, adequately separated trenches, the answer is '**Yes**.'

If there are concerns that trenches are too close, or that water and wastewater pipes are in a single trench, the answer is '**No**,' and the extent of this problem should be fully described in the **CARP**.

If it appears impossible to characterize the condition of distribution facilities, describe any circumstances leading to that in the CARP and as part of any related compliance correspondence.

3-11. Rule requirement

§290.44 contains the requirements for distribution system design, including details of separation distances for water and wastewater lines. The introduction to that portion of rule language is shown here:

"§290.44(e) Location of waterlines. The following rules apply to installations of waterlines, wastewater mains or laterals, and other conveyances/appurtenances identified as potential sources of contamination. Furthermore, all ratings specified shall be defined

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
by ASTM or AWWA standards unless stated otherwise. New mains, service lines, or laterals are those that are installed where no main, service line, or lateral previously existed, or where existing mains, service lines, or laterals are replaced with pipes of different size or material. §290.44(e)(1)When new potable water distribution lines are constructed, they shall be installed no closer than nine feet in all directions to wastewater collection facilities. All separation distances shall be measured from the outside surface of each of the respective pieces. …" If the assessor is not familiar with these requirements, they should probably seek expert assistance.			
3-11. Correction options If there is an issue with how the distribution system is built that could allow degradation of water quality, the assessor should consult with TCEQ about plans to start a program at the system to correct that sanitary defect and compliance issue. The assessor should consult with the TCEQ regarding planned corrections. The PWS should notify TCEQ of any proposed project, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted.			
Question 3-12. Are all dead-end mains flushed at monthly intervals and dead-end lines and other mains in the affected area(s) flushed as needed?	☐	☐	☐
3-12. Potential sanitary defect Since dead ends are a known hazard, TCEQ rules require monthly flushing. By periodically bringing fresh water into these locations, the bacterial persistence and regrowth can be controlled, sediment can be removed, and customer complaints can be minimized. Most importantly, the flushing ensures that an adequate residual is carried to the ends of the system. Failure to flush adequately is a sanitary defect. Consider where the dead ends are, particularly in the area of the TC+. Are they flushed monthly. Consider whether the system is constructed to allow stagnant areas or 'hydraulic' dead-ends near the TC+ location. (This may also be a consequence of having valves set incorrectly.) Review the dead-end main flushing program data. If no data is present, that may be a compliance issue, so review recent regional investigation reports to see if it has been cited yet. **3-12. Answers** If dead-end mains (and other identified stagnant areas) were flushed monthly, the answer is '**Yes**.' If dead-ends were not flushed monthly the answer is '**No**.' This should be explained in the **CARP**, along with an explanation about how the PWS will return to compliance. Some PWSs occupy a single site or building, and the definition of dead-end is problematic for these non-traditional distribution systems. The assessor may select '**N/A**' in this case, but the submittal needs to describe why. Even buildings can have stagnant areas that need to be flushed periodically just to get the bad water out and the good water in.			
3-12. Rule requirement TCEQ rules require flushing: "§290.46(l) Flushing of mains. All dead-end mains must be flushed at monthly intervals. Dead-end lines and other mains shall be flushed as needed if water quality complaints are received from water customers or if disinfectant residuals fall below acceptable levels as specified in §290.110 of this title."			

Questions on Section 3–Distribution system design, maintenance, pressure, and residual	Yes	No	N/A
TCEQ rules require that results of monthly flushing be maintained for at least two years: "§290.46(f)(2) The public water system's operating records must be accessible for review during inspections and be available to the executive director upon request. §290.46(f)(3) All public water systems shall maintain a record of operations. §290.46(f)(3)(A) The following records shall be retained for at least two years: … §290.46(f)(3)(A)(iii) the date, location, and nature of water quality, pressure, or outage complaints received by the system and the results of any subsequent complaint investigation; §290.46(f)(3)(A)(iv) the dates that dead-end mains were flushed; …"			
3-12. Correction options See Appendix 7 for additional information about flushing.			

Questions in Section 3: Nitrification

Appendix 4 will also be used for this section.

Systems that use chloramines for distribution system disinfection are at risk of nitrification. Nitrification is a natural microbial process that can cause a loss of residual and formation of nitrite and nitrate, which both can have very negative public health effects (they can cause blue-baby syndrome in infants). For those reasons, TCEQ has adopted regulations to help PWSs that use chloramines prevent, respond, and mitigate nitrification when it happens.

Chloramine effectiveness and nitrification monitoring are described in the system's Monitoring Plan. Daily sheets have the results of that monitoring. The required Nitrification Action Plan is an attachment to the Monitoring Plan.

The following questions, 3-13 and 3-14, apply to PWSs that have (or may have) chloramines present in their distribution system.

(Table 4. continued) Questions on Section 3–Distribution system nitrification questions	Yes	No	N/A
Question 3-13. If it was determined that nitrification occurred recently in the affected area(s) of the distribution system, did the PWS implement provisions of its Nitrification Action Plan (NAP) in the affected area(s) of the distribution system?	☐	☐	☐
Note: systems that only have free chlorine should answer 'N/A.' **3-13. Potential sanitary defect** In chloraminated systems, nitrification can cause rapid decreases in disinfectant residuals, which in turn can cause TC+. Nitrification is, unfortunately, a common sanitary defect in PWSs with chloramines. This questions has two parts: • First: did nitrification occur? • Second: if it did, was it addressed through a NAP? Consider whether nitrification occurred. Did residuals drop in certain areas? During the			

(Table 4. continued) Questions on Section 3–Distribution system nitrification questions	Yes	No	N/A
low residual period, did sampling show that ammonia levels were less than normal? Were there changes in nitrite or nitrate as compared with baseline levels? A PWS that has and follows an adequate NAP should be aware of a nitrification event essentially from its beginning. The core concept of a NAP is to be alert for changes that might indicate nitrification. Review the data to determine if any indicators of nitrification confirmed its presence. For example, lower- than-normal ammonia, increase or decrease in nitrite, increase in nitrate, pH drop, or any site-specific indicators identified in the NAP—such as microbial testing. Review the recent TCEQ investigation reports to see whether the PWS has been cited for failure to have or implement a NAP. The Assessor should review both the NAP and how it is used at the PWS. If either of these is not adequate, corrective action will be necessary. **3-13. Answers** Systems that have ONLY free chlorine should answer '**N/A'**. If nitrification DID NOT OCCUR, the answer is also '**N/A**'. If nitrification occurred and the NAP was implemented, the correct answer is '**Yes**.' If nitrification occurred and the NAP was NOT implemented, the correct answer is '**No**.' Any nitrification event should be described in the **CARP**.			
3-13. Rule requirement A NAP is required for systems distributing chloraminated water. "*§290.46(z) Nitrification Action Plan (NAP).* Any water system distributing chloraminated water must create a NAP. The system must create a written NAP that: §290.46(z)(1) contains the system-specific plan for monitoring free ammonia, monochloramine, total chlorine, nitrite, and nitrate levels; §290.46(z)(2) contains system-specific action levels of the above monitored chemicals where action must be taken; §290.46(z)(3) contains specific corrective actions to be taken if the action levels are exceeded; and §290.46(z)(4) is maintained as part of the system's monitoring plan in §290.121 of this title." The first portion of the rule specifying monitoring for chloramines is: "*§290.110(c)(5) Chloramine effectiveness sampling.* Public water systems with a chloramine residual shall monitor to ensure that monochloramine is the prevailing chloramine species and that nitrification is controlled. Sample sites and procedures used for chloramine effectiveness sampling must be documented in the system's nitrification action plan (NAP) required by §290.46(z) of this title (relating to Minimum Acceptable Operating Practices for Public Drinking Water Systems). Sample results determined by monitoring required under this paragraph will not be used to determine compliance with the maximum contaminant levels, MRDLs, action levels, or treatment techniques of this subchapter. …"			
3-13. Correction options Nitrification and NAPs are discussed in Appendix 4.			

(Table 4. continued) Questions on Section 3–Distribution system nitrification questions	Yes	No	N/A
Question 3-14. Was the PWS performing a temporary conversion to free chlorine in the affected area(s) of the distribution system during the time the total coliform-positive sample(s) was/were collected?	☐	☐	
Note: systems that only have free chlorine should answer 'N/A.' **3-14. Potential sanitary defect** A conversion to free chlorine involves flushing hydrants, which may stir up sediment resulting in TC+ samples. Always notify TCEQ at DBP@tceq.texas.gov before doing a temporary conversion to free chlorine. **3.14 Answers** If the PWS was NOT performing a temporary conversion to free chlorine during the period when TC+ was detected, the answer is '**No**.' If the PWS was performing a temporary conversion to free chlorine, the answer is '**Yes'**. If a free chlorine conversion was being performed, describe the situation in the **CARP**.			
3-14. Rule requirement A PWS that is approved to use chloramines must use chloramines or else notify the TCEQ—therefore, the PWS must consult with TCEQ prior to a temporary conversion to free chlorine. The TCEQ has the option to delay disinfection byproduct sampling for 30 days during the temporary conversion. Send an email to DBP@TCEQ.Texas.gov to notify the TCEQ.			
3-14. Correction options Collecting routine coliform samples when the system is in the process of transitioning from free chlorine to chloramines—or back again—may influence results. Avoid collecting bacteriological samples in an area that you have recently flushed very heavy. Give the area some time to settle back down before collecting a sample there. If an issue is found, the PWS should review the procedures for free chlorine conversions to make sure that the process for switching to free chlorine, and then back to chloramines, is well documented and that staff follow the procedures.			

Questions in Section 3: Cross-connection control and backflow prevention

The following questions, 3-15 through 3-17, are related to cross-connection control and backflow prevention in the distribution system.

Appendix 5 provides additional information about cross-connection control and backflow prevention.

(Table 4. continued) **Section 3–Distribution system** **Cross-connection control and backflow prevention questions**	Yes	No	N/A
Question 3-15. Were all backflow prevention assemblies tested and determined to be functioning at the positive sample site(s), as applicable?	☐	☐	☐

3-15. Potential sanitary defect

If routine or repeat coliform samples are collected inside a facility that is required to be separated from the distribution through a backflow prevention assembly, a TC+ may only represent the water inside the facility—not in distribution—thus causing a false positive. However, if the backflow prevention assembly was not working, the contaminant could have entered the distribution system.

This question has two parts:

- ***First:*** Were any of the sites where TC+ was detected required to have a backflow prevention assembly?
- ***Second:*** If so, were all required backflow prevention assembly working? Was their adequacy documented on testing and maintenance forms?

The assessor should determine the potential risks to the distribution system from hazards at the site which is required to have a backflow prevention assembly.

If data is not available, it may be a compliance issue—the assessor should look at recent TCEQ investigation reports and regulatory correspondence.

3-15. Answers

If NO sites that had TC+ are required to have a backflow prevention assembly, the correct answer would be '**N/A'**.

If ANY of the sites with TC+ are required to have backflow prevention assembly, and if ALL the backflow prevention assembly were tested and functioning, the answer would be '**Yes**.'

If ANY of the sites with TC+ are required to have backflow prevention assembly, and if ANY of the required backflow prevention devices were NOT tested, or were NOT functioning, the answer is '**No**,' which must be explained in the **CARP**.

3-15. Rule requirement

The initial part of the rule describing backflow is shown here:

"§290.44(h) Backflow, siphonage.

§290.44(h)(1) No water connection from any public drinking water supply system shall be allowed to any residence or establishment where an actual or potential contamination hazard exists unless the public water facilities are protected from contamination.

§290.44(h)(1)(A) At any residence or establishment where an actual or potential contamination hazard exists, additional protection shall be required at the meter in the form of an air gap or backflow prevention assembly. The type of backflow prevention assembly required shall be determined by the specific potential hazard identified in §290.47(f) of this title (relating to Appendices). …"

3-15. Correction options

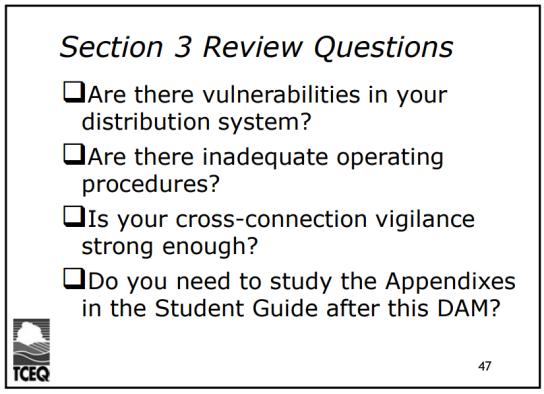
Coliform sampling is never recommended that taps at service connections that need to have backflow prevention devices. Backflow prevention devices are only required for connections with hazards—if the hazard is fecal, it can cause a false positive: only the water inside that connection should be at risk, the backflow prevention assembly should be keeping any bad water out of the distribution system in general.

If data is not available assessor and PWS should develop a compliance strategy for retaining data in future, and maintain that for review by TCEQ investigators.

(Table 4. continued) **Section 3–Distribution system** **Cross-connection control and backflow prevention questions**	Yes	No	N/A
Question 3-16. Was it determined that the distribution water was impacted by any other backflow-event?	☐	☐	
3-16. Potential sanitary defect If there was any backflow event, that could be a symptom of a sanitary defect. Consider recent water quality data, maintenance, construction, and complaints. Do they provide evidence that backflow occurred? Are there inexplicable results that could have been caused by a backflow event? The assessor should consider whether the backflow event was responsible for water quality degradation. If so, it may have triggered noncompliance that would be documented in the TCEQ investigation reports or regulatory correspondence. **3-16. Answers** If the data shows that no backflow event occurred, the answer would be 'No.' If a backflow event occurred, the correct answer is 'Yes'. The backflow event should be described in the CARP.			
3-16. Rule requirement Water quality standards are continuous. If backflow causes water quality degradation, that could be a compliance concern and is a sanitary defect.			
3-16. Correction options If a backflow event occurred, the assessor should consult with the TCEQ. If the hazard can be protected against by implementing a stronger Cross-Connection Control Program, or by installing a backflow prevention assembly, that should be done.			
Question 3-17. Are appropriate backflow prevention assemblies and/or air gap installed at every connection with a potential health hazard, and tested and determined to be functioning, as applicable?	☐	☐	☐
3-17. Potential sanitary defect The presence of hazards at connections without backflow protection is a sanitary defect, because the hazardous water could get sucked back into the distribution pipes (backsiphonage) and cause a sanitary defect in the distribution system. The assessor should consider whether the PWS adequately protects against allowing hazardous connections to potentially contaminate distribution pipes. The main documentation the assessor should review: • The PWS's list of hazardous connections that must have backflow prevention assemblies, and • The PWS's testing and maintenance forms for the backflow prevention assembles at those locations. The assessor should review recent CCI reports to see if the system was cited for violations of backflow prevention assembly testing and maintenance reports. **3-17. Answers** If every connection with a potential hazard has a tested, functioning backflow prevention assembly, as documented by the list of locations and testing and maintenance reports, the correct answer is '**Yes**.' If there is no substantiation that this is the case, the correct answer it '**No**.' If the system can document that no connections have potential health hazards present,			

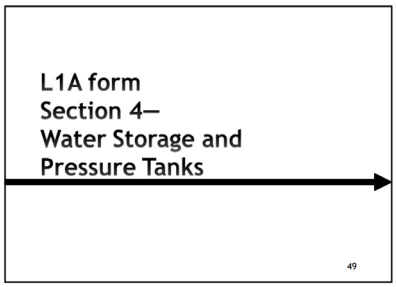
(Table 4. continued) **Section 3–Distribution system** **Cross-connection control and backflow prevention questions**	Yes	No	N/A
the correct answer would be '**N/A**.'			
3-17. Rule requirement The requirement to have backflow prevention assemblies installed where hazards are present. "§290.44(h)(1)(A) At any residence or establishment where an actual or potential contamination hazard exists, additional protection shall be required at the meter in the form of an air gap or backflow prevention assembly. The type of backflow prevention assembly required shall be determined by the specific potential hazard identified in §290.47(f) of this title (relating to Appendices). …" The assemblies must be tested annually: "§290.44(h)(4) All backflow prevention assemblies that are required according to this section and associated table located in §290.47(f) of this title shall be tested upon installation by a licensed backflow prevention assembly tester and certified to be operating within specifications. Backflow prevention assemblies which are installed to provide protection against health hazards must also be tested and certified to be operating within specifications at least annually by a licensed backflow prevention assembly tester. …" Record retention requirements are in "§290.46(f)(3) All public water systems shall maintain a record of operations. … §290.46(f)(3)(B) The following records shall be retained for at least three years: … §290.46(f)(3)(B)(v) the records of backflow prevention device programs; … §290.46(f)(3)(E) The following records shall be retained for at least ten years: … §290.46(f)(3)(E)(iv) copies of the Customer Service Inspection reports required by subsection (j) of this section;"			
3-17. Correction options If a PWS is not fully implementing a Cross-Connection Control Program, it is recommended that they do so. Additional information is in Appendix 5.			

Before moving on to Section 4, talk about the review questions shown on slide 47.



Notes

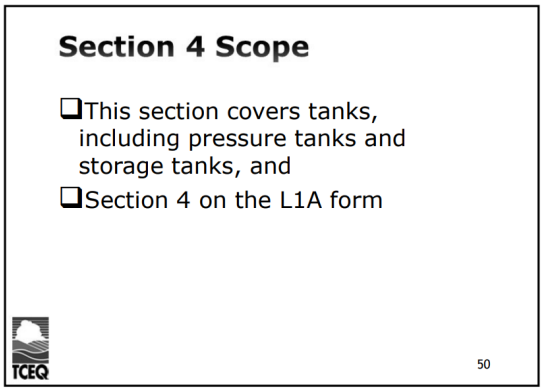
Section 4—Water Storage and Pressure Tanks



Tanks are an important part of the distribution system. They keep the water safe and available, when designed and operated correctly.

Scope

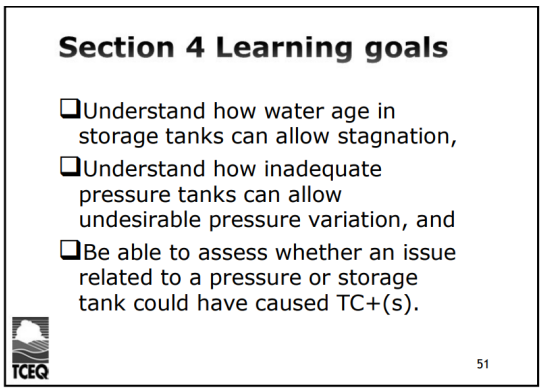
Section 4 covers tanks, including pressure tanks and storage tanks.



Learning goals

The learning goals for Workshop 3 are:

- Understand how water age in storage tanks can allow stagnation,
- Understand how inadequate pressure tanks can allow undesirable pressure variation, and
- Be able to assess whether an issue related to a pressure or storage tank could have caused TC+(s).



Materials

Documents the assessor may find helpful include the PWS's:

- ✓ Tank inspection forms,
- ✓ CCI reports and regulatory correspondence,
- ✓ Complaint records,

- ✓ Maintenance records,
- ✓ Construction records, and
- ✓ Plans and specifications, if other information about tank configuration is not available.

It may be necessary to review plans or interview engineers to evaluate features like baffles, mixers, or other equipment that is internal, so not easily observed.

Section 4 Materials

- ❑Documents
  - Tank inspection forms,
  - CCI reports and regulatory correspondence,
  - Complaint records,
  - Maintenance records,
  - Construction records, and
  - Plans and specifications,
- ❑On-site evaluation
- ❑Data? Chlorine residual?

TCEQ

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If the assessor does not have expertise related to the types of tanks present at the PWS being assessed, it is recommended that they seek expert assistance.

Section 4

All tanks that could impact the TC+ area must be assessed.

- A **small system** with a single storage tank and/or pressure tank must assess those tanks during a Level 1 Assessment.
- A **large system** with multiple storage and/or pressure tanks must assess tanks relatively near any TC+ locations. For example, tanks in the same pressure plane as the TC+ should be considered for assessment.

Figure 15 shows Section 4 of the Level 1 Assessment form.

Section 4 – Water Storage and Pressure Tanks	Yes	No	N/A
1. Are all pressure and storage tanks maintained and operational?	☐	☐	☐
2. Have all storage tanks been inspected in the past year?	☐	☐	☐
3. Have all pressure tank exteriors been inspected in the past year?	☐	☐	☐
4. Have all pressure tanks with inspection ports had an interior inspection in the past five years?	☐	☐	☐
5. Have all issues found during tank inspections been addressed?	☐	☐	☐
6. Are all tank openings and roof vents screened with 16-mesh or finer screen?	☐	☐	☐
7. Are all tank overflows fitted with a cover that closes automatically and has no gap over 1/16 inch?	☐	☐	☐
8. Is the PWS managing water turnover in finished water storage tanks to account for low water use to minimize and/or prevent excessive water age, as applicable?	☐	☐	☐
9. Does any tank have excessive sediment?	☐	☐	☐
10. Are clearwells, standpipes, ground storage, elevated tanks, and below ground storage tanks properly located away from hazards? (i.e., hazards such as: municipal or industrial sewage treatment plant; land which is spray irrigated with treated sewage effluent and/or sludge disposal; under buildings, sanitary sewer, septic tank and/or septic tank soil absorption system, etc.)	☐	☐	☐
11. Are all potable water storage tanks (including pressure tanks) thoroughly tight against leakage and were any applicable hatches locked?	☐	☐	☐
12. Were there any residual disinfectant concentrations below 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) present in any finished water storage tank, as applicable?	☐	☐	☐

Figure 15. Section 4 of the Level 1 Assessment form.

Tank assessment process: Summary

The process of assessing distribution will include:

- Review documents, specifically,
  - Tank inspection forms, and
  - Tank maintenance reports
- Review monitoring data,
  - Look at disinfectant residuals data at tanks, if available
- Review compliance data and regulatory correspondence,
  - CCI reports will most likely document any tank violations and/or additional issues,
- Interview staff to understand tank operation procedures, like high and low set points;
- Perform on-site investigation to verify findings from data and document review,
- Document any sanitary defects or additional issues in the CARP.

If the assessor does not have experience with tanks, it is recommended that they seek expert assistance.

Storage tanks

Storage tanks play an important role ensuring that adequate amounts water are available for customers. However, the benefits of having ample storage are balanced against concerns about water age. As water ages in storage tanks or other facilities, disinfectant degrades, bacteria can grow or regrow, and disinfection byproducts (trihalomethanes and haloacetic acids) increase.

Storage tanks are critical infrastructure, and may be a key vulnerability. If tank openings are not well protected, birds or other wildlife can enter and defecate. If screens are not covering all vents, insects can enter, lay eggs, and their larvae can enter the distribution system.

Elevated storage tanks that float on the system and are designed to take on water and discharge it through the same pipe are at an increased risk of stratification. Stratification is where the cooler, denser water is on the bottom and the warmer water is located in the upper level of the storage tank.

When fresh, cooler water from the distribution system enters the storage tank, it has a tendency to stay at the bottom, and as a result it is often the first to be released, leaving the warmer layer to age and degrade.

Pressure tanks

Pressure tanks are critical facilities for systems that don't have elevated storage. Many small systems use pressure tanks to even out the pressure provided by service pumps. If these systems have a non-functioning pressure tank, water hammer will destroy pipes and appurtenances over time.

List of Tanks

Systems may have more than one tank that could be a factor in TC+ occurrence. If so, each tank should be assessed. As a first step, it may be helpful to list the tanks that need to be assessed.

Most PWSs have at least two tanks. Each tank that could have impacted the affected area must be assessed. Section 4 must be completed and submitted for each site.

Extra forms for documenting the assessment of each site are in Appendix 11.

It is very helpful to list the tanks just to keep organized if there are multiple tanks.

Table of tanks

Table 5 provides a place for PWSs to list all of the tanks to be assessed. This table is also in Appendix 11 on the Level 1 Assessment form **WORK SHEET**.

Table 5. List of tanks

Tank # on list	Address (or location)	Storage or Pressure?	Ground or elevated?	Last inspection date	Tank sanitary, compliant, and functional?
1					
2					
3					
4					

(Add additional lines if needed.)

Tanks in Texas Drinking Water Watch

To double check on whether all tanks have been assessed, the assessor can check on Texas Drinking Water Watch. First, select the PWS being assessed on the main Texas Drinking Water Watch web page at:

dww2.tceq.texas.gov/DWW/

Figure 16 shows the first page, where you can select the PWSID or the name of the system to search for it.

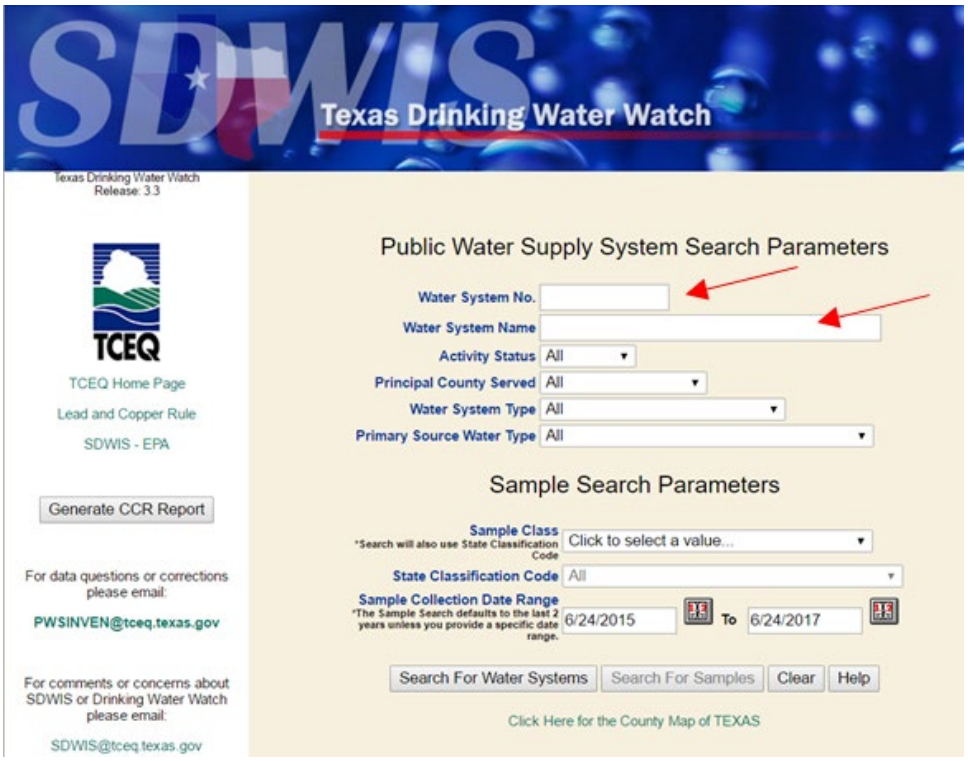


Figure 16. The first page of Texas Drinking Water Watch web site, showing where to enter the PWSID or name to search.

Questions in Section 4 of the Level 1 Assessment form

Table 6 list the questions on Section 4 of the Level 1 Assessment form in detail and describes potential sanitary defects, answers, and correction options for the issue addressed.

Table 6. Questions on Section 4 of the Level 1 Assessment form.

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
Question 4-1. Are all pressure and storage tanks maintained and operational?	☐	☐	☐
4-1. Potential sanitary defect Storage and pressure tanks should be secure, leak-free, sanitary, and free of sediment. Periodic inspections are required to ensure that tanks don't let contaminants in. Broken or poorly maintained tanks can cause TC+ by allowing contaminants to enter, or by harboring colonies of re-growing bacteria. The assessor should perform an on-site assessment of tanks in the affected area if they are not familiar with the system. The observed adequacy can then be verified with the maintenance documentation, for example—tank inspection forms. Inadequacy of tanks would likely be noted in CCIs, so the assessor should check those and reports and any other regulatory correspondence. **4-1. Answers** If ALL of the tanks are maintained and operational, the answer is '**Yes**.' If ANY of the tanks are not in good repair, the answer is '**No**.' If there is a problem with some tank that could be causing stagnation or contamination, the assessor should describe that in the **CARP**. If the status of equipment is an issue—for example, if needed repairs have not been done—the CARP should describe that.			
4-1. Rule requirements Storage tanks must be operational, as demonstrated by periodic inspections: "§290.46(m)(1) Each of the system's ground, elevated, and pressure tanks shall be inspected annually by water system personnel or a contracted inspection service. Tanks must be maintained: "§290.46(m)(4) All water treatment units, storage and pressure maintenance facilities, distribution system lines, and related appurtenances shall be maintained in a watertight condition and be free of excessive solids." "§290.46(m)(6) Pumps, motors, valves, and other mechanical devices shall be maintained in good working condition."			
4-1. Correction options Failure to adequately maintain and operate tanks may be noted in CCI reports as a violation. The assessor should consult with the TCEQ regarding planned tank repairs or replacement. The PWS should notify TCEQ of the project overview, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted.			
Question 4-2. Have all storage tanks been inspected in the past year?	☐	☐	☐
4.2 Potential sanitary defect Inadequate tank inspections can allow persistent degradation of tanks. That can cause a pathway for pathogens to enter through holes and such If ALL of the storage tanks have been inspected in the last year, the answer is '**Yes**.' If ANY of the tanks have not been inspected in the last year, the answer is '**No**,' and describe how this will be corrected. If tank inspections are performed as a corrective action during the 30-day window, the assessor should describe that in the **CARP**. If inspections are planned, but not completed, the assessor should consult with the			

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
TCEQ.			
4-2. Rule requirement Storage tanks must be inspected annually: "§290.46(m)(1)(A) Ground and elevated storage tank inspections must determine that the vents are in place and properly screened, the roof hatches closed and locked, flap valves and gasketing provide adequate protection against insects, rodents, and other vermin, the interior and exterior coating systems are continuing to provide adequate protection to all metal surfaces, and the tank remains in a watertight condition."			
4-2. Correction options Failure to adequately perform tank inspections may be noted in CCI reports as a violation. The assessor should coordinate any corrective actions in the Level 1 Assessment with the investigation corrective actions.			
Question 4-3. Have all pressure tank exteriors been inspected in the past year?	☐	☐	☐
4-3. Potential sanitary defect Inadequate tank inspections can allow persistent degradation of tanks. That can cause a sanitary defect. Also, when pressure tanks degrade, they can become non-functional and allow low pressure in the distribution system. If ALL of the pressure tank exteriors have been inspected in the last year, the answer is '**Yes**.' If ANY of the pressure tank exteriors have not been inspected in the last year, the answer is '**No**.' If tank inspections are performed as a corrective action during the 30-day window, the assessor should describe that in the **CARP**. If inspections are planned, but not completed, the assessor should consult with the TCEQ.			
4-3. Rule requirement Pressure tank exteriors must be inspected annually: "§290.46(m)(1)(B) Pressure tank inspections must determine that the pressure release device and pressure gauge are working properly, the air-water ratio is being maintained at the proper level, the exterior coating systems are continuing to provide adequate protection to all metal surfaces, and the tank remains in watertight condition. Pressure tanks provided with an inspection port must have the interior surface inspected every five years."			
4-3. Correction options Failure to adequately perform tank inspections may be noted in CCI reports as a violation. The assessor should coordinate any corrective actions in the Level 1 Assessment with the investigation corrective actions.			
Question 4-4. Have all pressure tanks with inspection ports had an interior inspection in the past five years?	☐	☐	☐
4-4. Potential sanitary defect Inadequate tank inspections can allow persistent degradation of tanks. That can cause a sanitary defect. Also, when pressure tanks degrade, they can become non-functional and allow low pressure in the distribution system. If ALL of the pressure tank interiors have been inspected in the last five years, the answer is '**Yes**.' If ANY of the pressure tank exteriors have not been inspected in the last five years, the			

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
answer is '**No**.' If tank inspections are performed as a corrective action during the 30-day window, the assessor should describe that in the **CARP**. If tank inspections are planned, but not completed, the assessor should consult with the TCEQ.			
4-4. Rule requirement Pressure tank interiors must be inspected every five years: "§290.46(m)(1)(B) Pressure tank inspections must determine that the pressure release device and pressure gauge are working properly, the air-water ratio is being maintained at the proper level, the exterior coating systems are continuing to provide adequate protection to all metal surfaces, and the tank remains in watertight condition. Pressure tanks provided with an inspection port must have the interior surface inspected every five years."			
4-4. Correction options Failure to adequately perform tank inspections may be noted in CCI reports as a violation. The assessor should coordinate any corrective actions in the Level 1 Assessment with the investigation corrective actions.			
Question 4-5. Have all issues found during tank inspections been addressed?	☐	☐	☐
4-5. Potential sanitary defect If tanks are not secure, leak-free, sanitary, and free of sediment pathogens can persist and regrow, causing a sanitary defect. If issues are found during periodic inspections, they must be corrected. The assessor should review tank inspection forms and maintenance, repair or replacement documentation. This documentation should be verified against photos and/or on-site observations. Inadequacy of tanks would likely be noted in CCIs, so the assessor should check those and reports and any other regulatory correspondence. **4-5. Answers** If ALL of the issues found in tank inspections were addressed, the answer is '**Yes**.' If ANY issues found in tank inspections at ANY tank were NOT addressed, the answer is '**No**' and that should be reported in the CARP. If no issues were found during the tank inspections, the correct answer would be 'N/A'.			
Rule requirement Good maintenance is a rule requirement: "§290.46(m)(4) All water treatment units, storage and pressure maintenance facilities, distribution system lines, and related appurtenances shall be maintained in a watertight condition and be free of excessive solids." Operability is a rule requirement: "§290.46(m)(6) Pumps, motors, valves, and other mechanical devices shall be maintained in good working condition."			
4-5. Correction options Failure to adequately address tank inspections may be noted in CCI reports as a violation. The assessor should coordinate any corrective actions in the Level 1 Assessment with the investigation corrective actions.			

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
Question 4-6. Are all tank openings and roof vents screened with 16-mesh or finer screen?	☐	☐	☐

4-6. Potential sanitary defect

It is necessary to have some openings in tanks to allow overflow, and to allow air to enter so that the tank does not collapse. However, those openings can allow bugs or other vermin to enter and contaminate tanks if the holes are too big. Midge flies can get into gaps larger than 1/16", lay eggs, and allow larvae (worms) to be present in customers' drinking water.

CCIs are likely to address this type of inadequacy, so the assessor should check investigation reports and any other regulatory correspondence.

4-6. Answers

If ALL tank overflows or other covers close tight and openings are covered with 16-mesh or finer corrosion-resistant screen, the answer is **'Yes'**

If ANY gaps greater than 1/16" are present, or if any openings are unscreened (or screened with two loose a screen), (on ANY tanks) the correct answer is **'No**.' This should be addressed in the CARP.

4-6. Rule requirement

Roof vent and tank opening design is in the rules:

"§290.43(c)(1) Roof vents shall be gooseneck or roof ventilator and be designed by the engineer based on the maximum outflow from the tank. Vents shall be installed in strict accordance with current AWWA standards and shall be equipped with approved screens to prevent entry of animals, birds, insects and heavy air contaminants. Screens shall be fabricated of corrosion-resistant material and shall be 16-mesh or finer. Screens shall be securely clamped in place with stainless or galvanized bands or wires and shall be designed to withstand winds of not less than tank design criteria (unless specified otherwise by the engineer)."

4-6. Correction options

Any gaps greater than 1/16" should be repaired. All openings should be screened with corrosion-resistant 16-mesh or finer screen (for example, 18-mesh).

Incorrect screens may be noted in CCI reports as a violation. The assessor should coordinate any corrective actions in the Level 1 Assessment with any other required corrective actions from investigations.

Question 4-7. Are all tank overflows fitted with a cover that closes automatically and has no gap over 1/16 inch?	☐	☐	☐

4-7. Potential sanitary defect

It is necessary to have some an overflow so that the tank can be drained if needed. The covers on these overflows must not allow bugs or other vermin to enter and contaminate tanks or that would be a sanitary defect.

4-7. Answers

If ALL tank overflows or other covers close tight and openings are covered with 16-mesh or finer corrosion-resistant screen, the answer is 'Yes'

If ANY gaps greater than 1/16" are present, or if any openings are unscreened (or screened with two loose a screen), (on ANY tanks) the correct answer is 'No.' This should be addressed in the CARP.

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
4-7. Rule requirement The applicable rules include: "§290.43(c)(3) Overflows shall be designed in strict accordance with current AWWA standards. If the overflow terminates at any point other than the ground level, it shall be located near enough and at a position accessible from a ladder or the balcony for inspection purposes. The overflow(s) shall be sized to handle the maximum possible fill rate without exceeding the capacity of the overflow(s). The discharge opening of the overflow(s) shall be above the surface of the ground and shall not be subject to submergence. The discharge opening shall be covered with a gravity-hinged and weighted cover, an elastomeric duckbill valve, or other approved device to prevent the entrance of insects and other nuisances. When the tank is not overflowing, the cover shall close automatically and fit tightly with no gap over 1/16 inch."			
4-7. Correction options Covers should be replaced or prepared if there are gaps greater than 1/16". All openings should be screened with corrosion-resistant 16-mesh or finer screen (for example, 18-mesh). Incorrect overflow covers may be noted in CCI reports as a violation. The assessor should coordinate any corrective actions in the Level 1 Assessment with any other required corrective actions from investigations.			
Question 4-8. Is the PWS managing water turnover in finished water storage tanks to account for low water use to minimize and/or prevent excessive water age, as applicable?	☐	☐	☐
4-8. Potential sanitary defect Excessive water age may lead to violations of disinfectant residual, disinfection byproducts, and coliform rules and thus be a sanitary defect. Short circuiting allows bulk water in a tank to become stagnant. While flow is normal, the stagnant water remains in the tank. However, at times when flow is higher, the stagnant water is drawn into the distribution system where it can cause low residuals and possibly the introduction of sediment from the bottom of the tank. **4-8. Answers** If the storage tanks are designed and operated to minimize water age, the correct answer is **'Yes**.' If the storage tanks have any design or operation issues that cause short circuiting or high water age, the answer would be **'No**.' Any issues related to tank operation and water age should be explained in the **CARP** even if they were not determined to be directly related to the TC+. If tank cycling or other operational practices are changed in order to shorten water age are changed as a result of the Level 1 Assessment, that should be explained in the CARP.			
4-8. Rule requirement The applicable rules include: "§290.43(c)(5) Inlet and outlet connections shall be located so as to prevent short-circuiting or stagnation of water. Clearwells used for disinfectant contact time shall be appropriately baffled."			

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
4-8. Correction options If a storage tank design causes excessive water age and short-circuiting, mixing units, re-configuring the inlet/outlet design, or adding baffling may be needed to prevent excessive water age. If additional time is needed for construction, the Assessor should consult with the TCEQ and submit a FAST describing the planned work and how it will be funded. It may be helpful to develop SOPs for deep cycling of storage facilities to ensure that stored water stays fresh.			
Question 4-9. Does any tank have excessive sediment?	☐	☐	☐
4-9. Potential sanitary defect When sediment collects in the bottom of a tank, it uses up chlorine and allows bacteria to persist or regrow, causing a sanitary defect. Tank inspections and maintenance reports should allow the assessor to determine whether any tanks have excessive sediment. If not, operator interviews and on-site evaluation may help. **4-9. Answers** If the PWS has NO storage tanks, the correct answer is **N/A'**. If NO storage tanks have sediment, the correct answer is **'No**.' If ANY storage tanks have sediment, the answer would be **'Yes**.' and it should be explained in the **CARP**. If tanks are cleaned as a result of the Level 1 Assessment, that should be explained in the CARP.			
4-9. Rule requirement The applicable rules include: "§290.43(c)(7) Each clearwell or potable water storage tank shall be provided with a means of removing accumulated silt and deposits at all low points in the bottom of the tank. Drains shall not be connected to any waste or sewage disposal system and shall be constructed so that they are not a potential agent in the contamination of the stored water. Each clearwell or potable water storage tank must be designed to drain the tank."			
4-9. Correction options If a storage tank design causes excessive sediment, it may need retrofitting with mixers or some other engineered solution. If additional time is needed for construction, the Assessor should consult with the TCEQ.			

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
Question 4-10. Are clearwells, standpipes, ground storage, elevated tanks, and below ground storage tanks properly located away from hazards? (i.e., hazards such as: municipal or industrial sewage treatment plant; land which is spray irrigated with treated sewage effluent and/or sludge disposal; under buildings, sanitary sewer, septic tank and/or septic tank soil absorption system, etc.)	☐	☐	☐

4-10. Potential sanitary defect

Leaking or poorly maintained tanks near hazards have been shown to be vulnerable to pathogen contamination—known as sanitary defects.

Tank inspection forms and on-site evaluations should help the assessor determine if potential contamination is present.

4-10. Answers

If a PWS has NO clearwells, standpipes, ground storage, elevated tanks, or below ground storage tanks, the answer would be '**N/A'**.

If ALL clearwells, standpipes, ground storage, elevated tanks, and below ground storage tanks are properly located away from hazards the answer would be '**Yes**.'

If ANY clearwells, standpipes, ground storage, elevated tanks, or below ground storage tanks are not properly located away from hazards, the answer would be '**No'** and that should be explained in the **CARP**.

4-10. Rule requirements

The applicable rules include:

"§290.43(b) Location of clearwells, standpipes, and ground storage and elevated tanks.

§290.43(b)(1) No public water supply elevated storage or ground storage tank shall be located within 500 feet of any municipal or industrial sewage treatment plant or any land which is spray irrigated with treated sewage effluent or sludge disposal.

§290.43(b)(2) Insofar as possible, clearwells or treated water tanks shall not be located under any part of any buildings and, when possible, shall be constructed partially or wholly above ground.

§290.43(b)(3) No storage tank or clearwell located below ground level is allowed within 50 feet of a sanitary sewer or septic tank. However, if the sanitary sewers are constructed of 150 pounds per square inch (psi) pressure-rated pipe with pressure-tested, watertight joints as used in water main construction, the minimum separation distance is ten feet.

§290.43(b)(4) No storage tank or clearwell located below ground level is allowed within 150 feet of a septic tank soil absorption system."

4-10. Correction options

If a tank is too close to a hazard, it should be corrected—not just to ensure safe water, but also to avoid future violations. If additional time is needed for construction, the Assessor should consult with the TCEQ.

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
Question 4-11. Are all potable water storage tanks (including pressure tanks) thoroughly tight against leakage and were any applicable hatches locked?	☐	☐	☐

4-11. Potential sanitary defect

If tanks are not tight against leakage—it means that there are holes where vermin can enter bringing pathogens along with them. If hatches are not locked, human vermin can enter the tank and contaminate the water.

4-11. Answers

If the PWS has NO tanks, the answer is 'N/A'.

If ALL tanks at the system are tight against leakage AND all applicable hatches are locked, the answer is 'Yes'.

If ANY tanks at the system are *not* tight against leakage OR ANY applicable hatches are *not* locked, the answer is 'No' and an explanation must be provided in the CARP.

4-11. Rule requirements

The applicable rules include:

"§290.43(c)(6) Clearwells and potable water storage tanks shall be thoroughly tight against leakage, shall be located above the groundwater table, and shall have no walls in common with any other plant units containing water in the process of treatment. All associated appurtenances including valves, pipes, and fittings shall be tight against leakage."

and

"§290.43(c)(2) All roof openings shall be designed in accordance with current AWWA standards. If an alternate 30-inch diameter access opening is not provided in a storage tank, the primary roof access opening shall not be less than 30 inches in diameter. Other roof openings required only for ventilating purposes during cleaning, repairing or painting operations shall be not less than 24 inches in diameter or as specified by the licensed professional engineer. An existing tank without a 30-inch in diameter access opening must be modified to meet this requirement when major repair or maintenance is performed on the tank. Each access opening shall have a raised curbing at least four inches in height with a lockable cover that overlaps the curbing at least two inches in a downward direction. Where necessary, a gasket shall be used to make a positive seal when the hatch is closed. All hatches shall remain locked except during inspections and maintenance."

4-11. Correction options

If a tank is not tight against leakage, it needs to be corrected. If leaks are repaired in response to the Level 1 Assessment, this should be explained in the CARP.

If hatches are not locked—the question is 'why?' If the hatches CAN be locked, but weren't—someone needs to be retrained. If the hatch can't be locked, that is a repair need.

Section 4–Water Storage and Pressure Tanks	Yes	No	N/A
Question 4-12. Were there any residual disinfectant concentrations below 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) present in any finished water storage tank, as applicable?	☐	☐	☐

4-12. Potential sanitary defect

The presence of disinfectant residual is one of the major barriers to pathogens in distribution systems. If required disinfectant residual samples were not collected, low-residual, high-risk areas may exist without detection causing sanitary defects.

The assessor should review the recent disinfectant residual results, focusing on results near the TC+s. However, since residual maintenance is a system-wide concern, the assessor should review all results.

Note: This data is a ***required attachment*** to the Level 1 Assessment submittal.

4-12. Answers

If the system has NO finished water storage tanks, the answer is '**N/A**.'

If no low residuals were noted anywhere in the system, the answer is '**No'**.

If low residuals occurred, the answer is '**Yes**,' and this answer should be described in the **CARP**. The impacted area, level of residual, and responses by the system should be documented.

If this data is not available, that may be a violation of TCEQ rules. In that case, the **CARP** should describe how changes will be made to comply with the rules.

(Note—this information is also included in question 3-6.)

4-12. Rule requirement

The applicable rules include

"§290.46(d)(2) The disinfection equipment shall be operated to maintain the following minimum disinfectant residuals in each finished water storage tank and throughout the distribution system at all times:

§290.46(d)(2)(A) a free chlorine residual of 0.2 milligrams per liter (mg/L); or

§290.46(d)(2)(B) a chloramine residual of 0.5 mg/L (measured as total chlorine) for those systems that distribute chloraminated water."

Additionally, all Texas PWSs must maintain disinfectant residuals at all locations, at all times:

"§290.110(a) Applicability. All public water systems shall properly disinfect water before it is distributed to any customer and shall maintain acceptable disinfectant residuals within the distribution system.

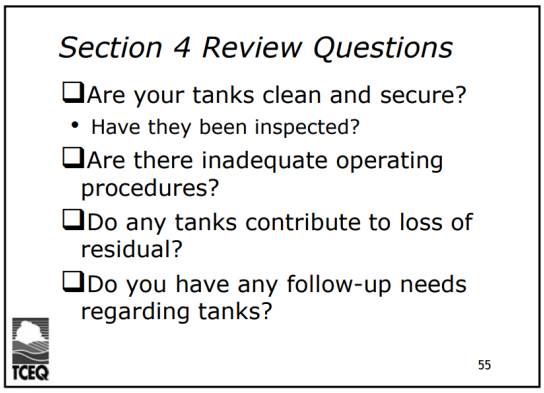
§290.110(b)(1) The disinfection process used by public water systems must ensure that water has been adequately disinfected before it enters the distribution system.

§290.110(b)(4) The residual disinfectant concentration in the water within the distribution system shall be at least 0.2 mg/L free chlorine or 0.5 mg/L chloramine (measured as total chlorine)."

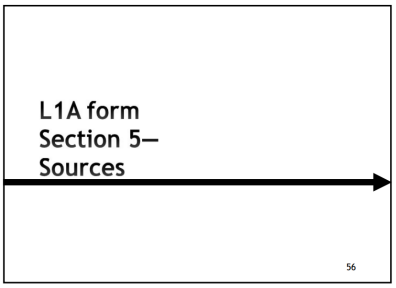
4-12. Correction options

Appendix 3B discusses residual maintenance in greater detail.

Before moving on to Section 5, review the questions on slide 55.



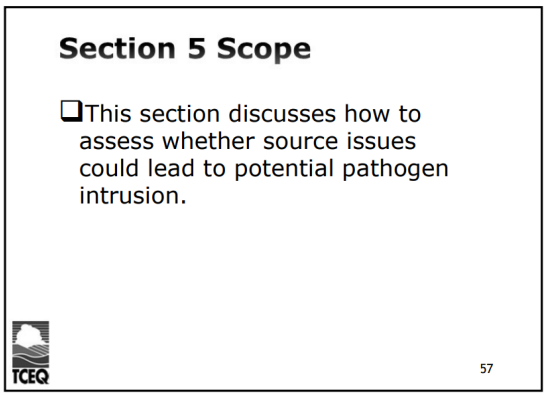
Section 5—Sources



The old saying is 'Start right—stay right.' If source water is heavily contaminated, that contamination can persist and pass through the barriers of treatment. If the downstream barriers are not robust, even slightly contaminated water can cause a risk to customers.

Scope

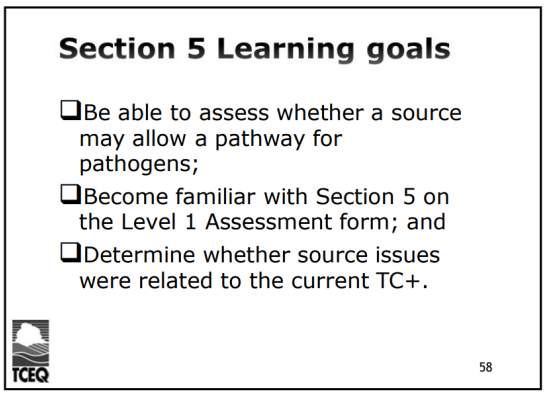
This section discusses how to assess whether source issues could lead to potential pathogen intrusion.



Learning goals

The learning objectives for this workshop include:

- Be able to assess whether a source may allow a pathway for pathogens;
- Become familiar with Section 5 on the Level 1 Assessment form; and
- Determine whether source issues were related to the current TC+.



Supporting documentation to review

The following supporting documentation is helpful to this part of the Level 1 Assessment:

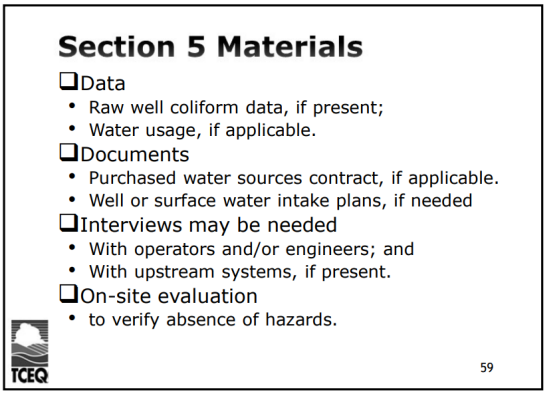
- ✓ Raw water sample data, if present;
- ✓ Monthly operating reports of water usage, if applicable.

It may be necessary to gather additional information during the assessment, for example:

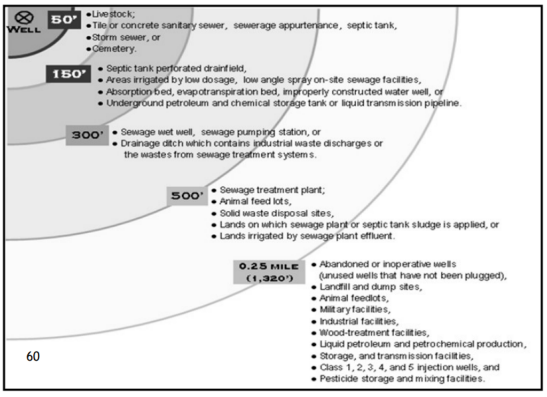
- ✓ Interviews with operators and/or engineers; and
- ✓ Interviews with upstream systems, if present.

If purchased water sources are present, data from the supplier will also be assessed, as well as any documentation setting standards for the purchased water—such as a contract.

If surface water sources are present, information will be needed on how the surface water intake was designed, and how it is operated.



If the assessor does not have expertise related to the source-types present at the PWS being assessed, it is recommended that they seek expert assistance.



Section 5

Figure 17 shows Section 5—Sources on the Level 1 Assessment form.

Section 5 – Sources			
Wells – *If the PWS does not have wells, check here and skip this section:* **(Including Groundwater under the direct influence of surface water (GUI))**			☐
	Yes	**No**	**N/A**
1. Does the PWS control and protect land within 150 feet of each well?	☐	☐	
2. Does every well have a sanitary control easement (SCE) or SCE exception?	☐	☐	☐
3. Are there known hazards within 50 - 500 feet of any well, as applicable? (i.e., hazards such as: septic system and related appurtenances; livestock; etc.)	☐	☐	
4. Is the wellhead and pump base constructed and sealed properly to minimize contamination?	☐	☐	
5. Are all well casing vents and applicable air release devices covered with 16-mesh or finer screen?	☐	☐	
6. Are all well blow-off lines (if provided) constructed so that the discharge will not be submerged by flood waters?	☐	☐	☐
7. Has an unusual raw water contamination incident or flooding incident occurred at the well site?	☐	☐	
Purchased Water – *If the PWS does not purchase water, check here and skip this section:*			☐
	Yes	**No**	**N/A**
1. Are all the entry point meters, vaults, and sample taps sanitary?	☐	☐	
2. Is the water supplier experiencing issues with coliform bacteria?	☐	☐	
Surface Water – *If the PWS does not use surface water, check here and skip this section:*			☐
	Yes	**No**	**N/A**
1. Is every surface water intake functional and operated correctly?	☐	☐	
2. Has an unusual raw water contamination incident occurred at the intake site?	☐	☐	

Figure 17. Section 5—Sources

List of sources

If multiple sources are present, it may be helpful to list those. Table 7 (longer version in Appendix 11) provides a place to list multiple sources as an organizational tool.

Table 7. List of Sources

Source # on list	Source name	Type	Sanitary?	Date of on-site evaluation
Example Source x	*Well A, Ash Pump Station, 1254 Ash Street*	*GW*	*Yes*	*4/1/16*
Source 1				
Source 2				
Source 3				
Source 4				

(Add additional lines if needed.)
NOTE: See Appendix 11 for a longer version of this form.

Sources in Texas Drinking Water Watch

To double check on what sources need to be assessed, the assessor can check on Texas Drinking Water Watch.

First, select the PWS being assessed on the main Texas Drinking Water Watch web page at:

dww2.tceq.texas.gov/DWW/

Figure 18 shows the first page, where you can select the PWSID or the name of the system to search for it.

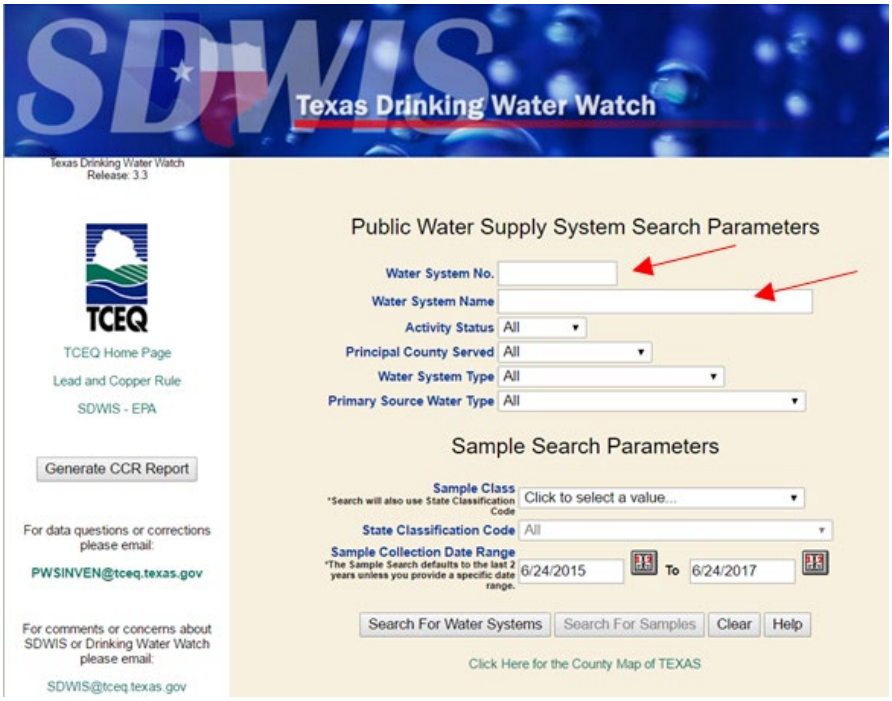


Figure 18. The first page of Texas Drinking Water Watch web site, showing where to enter the PWSID or name to search.

Source assessment process: Summary

Different types of sources will be handled differently. Generally speaking, the process of assessing sources will include:

- Review any available raw-water monitoring data,
- Review compliance data and regulatory correspondence,
- Perform on-site assessment if needed,
- Interview staff to verify data, and
- Document any issues.

If any degradation or change in source water quality occurred it should be described in the CARP.

Wells

If a PWS does not have any wells, the assessor should check 'N/A' and move to the next section on the form.

A
ll groundwater sources, including wells that are determined to be hydrogeologically sensitive or GUI, are considered in Section 5. Assessors should evaluate wells that provide water to the area where the TC+ occurred.

- A **small system** would probably need to assess every well, since they would probably send water to the area with the TC+.
- A **large system** with multiple wells can confine the assessment to wells that send water to the area with the TC+. For example, the wells that feed that pressure plane, as shown in the Monitoring Plan or Triggered Source Monitoring Plan.
    - In the absence of documentation substantiating which wells serve that area, all wells should be evaluated.

When assessing wells, the assessor will:

- Review documents about hazards in the vicinity of the well
    - Specifically, Sanitary Control Easements and related documentations
- Review any available monitoring data,
    - Results of raw monitoring for an exception or whatever,
- Review compliance data,
- Visit well sites:
    - Verify documents that were reviewed
    - Identify any other hazards present that were not noted in the documentation,
    - Evaluate whether wells are sanitary, maintained adequately, and operable;
- Document any sanitary defects or additional issues in the CARP.

If the assessor does not have experience with wells, it is recommended that they seek expert assistance.

Documents

Documents that will be needed for this portion of the workshop include:

- ✓ Ownership documentation—like plat maps or design drawings;
- ✓ Sanitary Control Easement (SCE) documentation;
- ✓ Scale map of well sites, showing fences and gates;
- ✓ Plans/schematics of well construction; and
- ✓ Correspondence with TCEQ related to well approval and construction.

If present, additional documents may be helpful:

- ✓ Correspondence related to Comprehensive Compliance Investigations (or other investigations) by the TCEQ Regional Investigator;
- ✓ Triggered Source Monitoring Plan, if a subset of wells is being assessed; and/or

- ✓ Source Water Protection Program documentation.

On-site assessment

After reviewing the available data and documentation, an on-site examination of well areas is the best method to identify any potential unsanitary or poor conditions, and to verify the conditions described in the documentation.

Every area with wells must be sanitary, in accordance with §290.46(m). These areas should be clean, mowed, free of trash, free of areas that may harbor rodents or other vermin, and surrounded by a fence with a locked gate. These conditions are well established as 'sanitary.'

There are numerous TCEQ rules related to minimum standards maintaining sanitary conditions near wells. For example, §290.41(c)(3)(I) requires that the well site be fine graded so that the site is free from depressions, reverse grades, or areas too rough for proper ground maintenance so as to ensure that surface water will drain away from the well and provides additional requirements for collecting and draining water away from the well.

Additionally, §290.46(m) requires that PWSs ensure the good working condition and general appearance of the system's facilities and equipment. The grounds and facilities shall be maintained in a manner so as to minimize the possibility of the harboring of rodents, insects, and other disease vectors, and in such a way as to prevent other conditions that might cause the contamination of the water.

Hazards

Texas has implemented rules regarding well siting and wellhead protection since 1937. The underlying principle is basic: if pathogenic sources are close to a well, those pathogens can permeate through the soil and rock and get into the aquifer the well is drawing from. The requirements for groundwater sources are in §290.41.

Specific hazards

Some specific hazards are noted in the TCEQ regulations under §290.41, as shown in Figure 19.

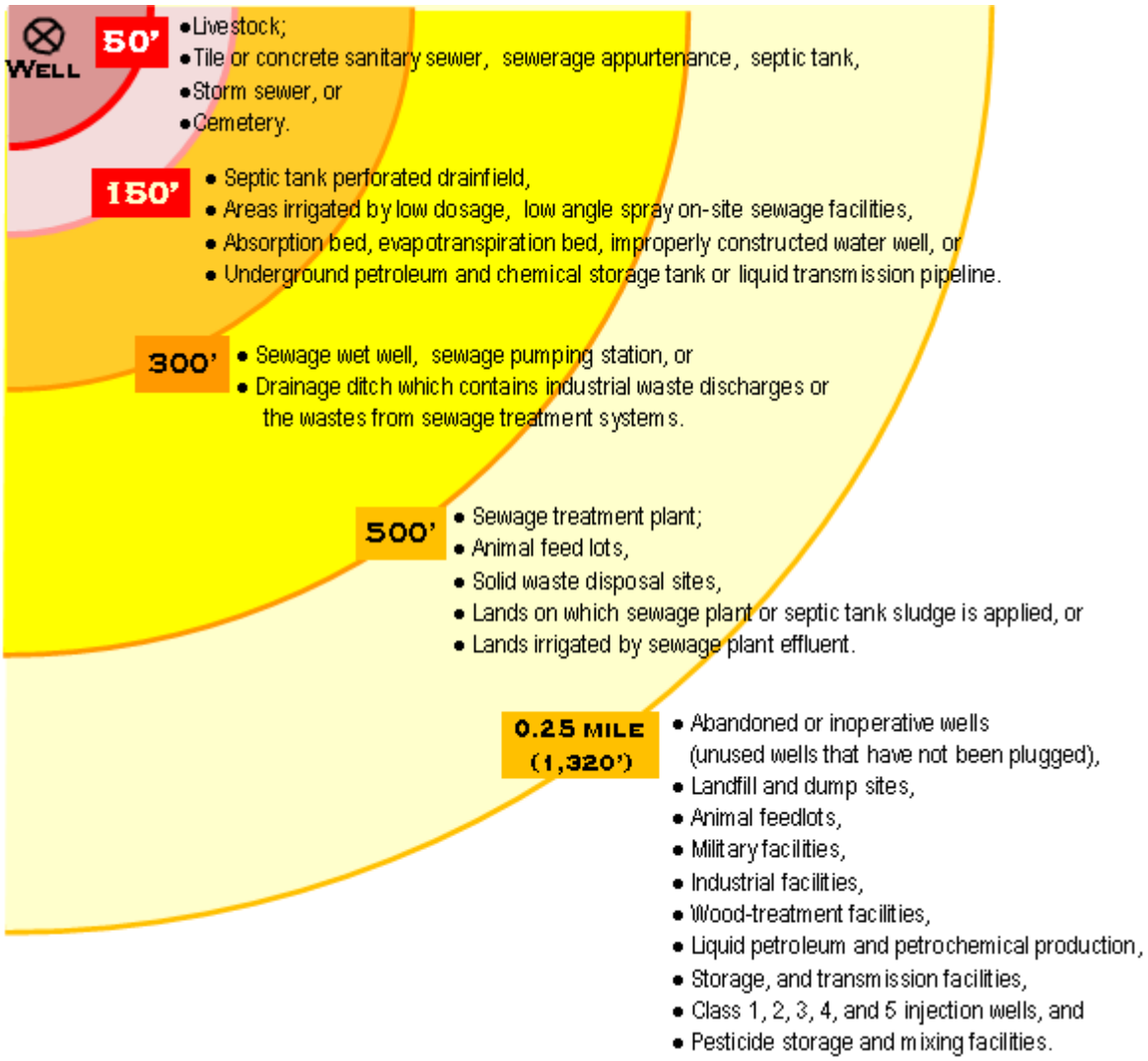


Figure 19. Regulatory setbacks

The assessor needs to consider whether any well may be vulnerable to contamination.

One potential pathway for pathogens is nearby fecal matter or putrefaction. Consider whether there any known hazards—also known as potential-sources-of-contamination (PSOCs) close to a well. The closer a hazard is to a well, the greater the risk.

Review the records and well maps. Review the records of TCEQ Comprehensive Compliance Investigations. Determine whether any historical issues exist. Determine whether any regulatory issues are present.

Consider:

- Do all assessed wells meet the setback distances of §290.41(c)?
- If not, are wells operating under a TCEQ exception with site-specific?

If more than one well is being assessed, review all wells when answering the questions.

Risks to drinking water wells come from things like animal waste, sewage, spilled chemicals, etc. Fecal sources are of greatest concern, for example,

- Septic tanks or fields—especially older ones;
- Cattle—especially feeding operations, but also grazing;
- Sewage—storage facilities or treatment facilities;
- Low-lying areas—any standing water can breed pathogens;
- Any other activity that could provide a source of pathogens; and
- Any other hazard identified in §290.41(c); or
- Any other source of fecal matter.

Wellhead protection tools

The assessor needs to consider whether the PWS protects and controls the land immediately surrounding wells, to ensure that the well is not at risk of contamination. The on-site assessment

Review of the plat maps, well construction documents, County Appraisal District records, or other land-ownership information should will be useful.

The TCEQ minimum standards for protection and control of the area around the wells are described in §290.41(c). The regulations focus on the area 150' from wells, but if a fecal source 151' or farther from a well is causing bacteria to enter a well it could be a non-regulatory sanitary defect.

Possible ways that the PWS can control activities are:

- By owning the land,
- By having a SCE, or
- By having a TCEQ-approved exception covering the area 150 feet of the assessed wells and meeting all of the conditions of that exception.

Regardless of ownership, fecal sources around a well need to be controlled and limited.

In some cases, a PWS is lucky enough to own the land around wells—a very effective way of ensuring their ability to protect and control it.

However, if the PWS does own that land, but does not maintain or control potential contamination in that area, a sanitary defect could still be identified under question

In cases where the PWS does not own the land around a well, the TCEQ minimum standards require that they enter into a Sanitary Control Easement (SCE) with landowners in a 150' radius of the well. This is described in the TCEQ rules in §290.41(c)(1)(E).

Finally, if the PWS does not own the land, or have an SCE, the PWS should have a TCEQ-approved alternate compliance strategy, known as an 'exception.' Exceptions are documented in letters from the TCEQ to the PWS, listing out the conditions that must be followed in order to protect public health, as long as the PWS does not meet the letter of the rule.

A typical exception condition would be to collect raw well water samples to determine whether contamination is reaching the well.

A PWS that assesses a well and finds that it does not have one of the protection methods listed will need to correct the situation. The assessor should consult with the TCEQ to discuss options.

Regulated hazards within 50' of a well

A hazard within 50’ of a drinking water well would be a grave concern. In karstic limestone or sand, cracks can carry water rapidly underground, so contamination could be very likely.

Some specific hazards are listed in §290.41(c)(1)(A). For example:

- Tile or concrete sanitary sewer,
- Sewerage appurtenance,
- Septic tank,
- Storm sewer, or
- Cemetery.

Additionally, §290.41(c)(1)(D) lists livestock as a concern. Other hazards not specifically listed could also be a concern.

Regulated hazards within 150' of a well

A hazard within 150’ of a drinking water well would be a concern.

Some specific concerns at this distance listed in §290.41(c)(1)(A) include:

- Septic tank perforated drainfield,
- Areas irrigated by low dosage,
- Low angle spray on-site sewage facilities,
- Absorption bed,
- Evapotranspiration bed,
- Improperly constructed water well, or
- Underground petroleum and chemical storage tank or liquid transmission pipeline.

Other hazards not specifically listed could also be a concern.

Regulated hazards within 300' of a well

A hazard within 300’ of a drinking water well could be a concern.

Three specific concerns at this distance listed in §290.41(c)(1)(B) include:

- Sewage wet well,
- Sewage pumping station, or
- Drainage ditch which contains industrial waste discharges or the wastes from sewage treatment systems.

Other hazards not specifically listed could also be a concern.

Regulated hazards within 500’ of a well

A hazard within 500’ of a drinking water well could be a concern.

The specific concerns at this distance listed in §290.41(c)(1)(B) is:

- A sewage treatment plant.

- Additionally, §290.41(c)(1)(C) lists concerns at this distance:
- Animal feed lots,
- Solid waste disposal sites,
- Lands on which sewage plant or septic tank sludge is applied, or
- Lands irrigated by sewage plant effluent.

Other hazards not specifically listed could also be a concern.

Regulated hazards within a quarter mile of a well

A hazard within a quarter mile of a drinking water well could be a concern, especially in karstic limestone or other fractured or porous rock. In 1998, Brushy Creek, TX had their wells contaminated by a creek over a quarter mile away, when a sewer overflow occurred.

Some potential hazards listed in §290.41(c)(1)(E) include:

- Abandoned or inoperative wells (unused wells that have not been plugged),
- Landfill and dump sites,
- Animal feedlots,
- Military facilities,
- Industrial facilities,
- Wood-treatment facilities,
- Liquid petroleum and petrochemical production,
- Storage, and transmission facilities,
- Class 1, 2, 3, 4, and 5 injection wells, and
- Pesticide storage and mixing facilities.

Other hazards not specifically listed could also be a concern.

The well site should be cleaned up if it is not sanitary. Plans should be made to ensure sanitation and maintenance of the well site if additional resources are needed to accomplish that. If larger projects like removing debris or extensive fence repair are needed, and additional time will be requested, the Assessor should consult with the TCEQ and develop a plan.

Construction and maintenance

Questions 5-4, 5, and 6 on the Level 1 Assessment form cover wellhead construction and maintenance.

Flood levels

Any flooding that impacts a well could be a pathway for pathogens. Flood water contains all the dirt picked up by the flood, including animal feces from the ground and human feces from compromised sewage systems.

The rules in §290.41(c)(3) describe how wells must be protected from flooding.The Assessor should consider any potential risk from flooding, in addition to the situations specifically addressed by rule. With changes in weather patterns, the 100-year flood elevation may change also. Also, growth in an area may cause local floods to disseminate less quickly because of more impermeable cover.

Specifically, §290.41(c)(3)(K) notes that wellheads and well vents shall be at least two feet above the highest known watermark or 100-year flood elevation, if available, or adequately protected from possible flood damage by levees.

Overflow

It is natural that openings are needed on wells—notably air release valves and overflows. However, if those opening are too large, insects and other varmints can get into the well. The most common insect that contaminates wells is a fly which can enter through holes over 1/16". The flies can lay eggs on pipe walls, and when the eggs hatch, the larvae (worms) can be distributed to customers.

The TCEQ's rules include minimum protection standards, for example well casing vents openings must be covered with 16-mesh or finer corrosion-resistant screen, facing downward, elevated [§290.41(c)(3)(K)]. Further, all openings to the atmosphere shall be covered with 16-mesh or finer, corrosion-resistant screening material or an acceptable equivalent according to §290.41(c)(3)(Q).

Well blow-off line

Additional protection is provided by the rules in §290.41(c)(3)(L) which require that if a well blow-off line is provided, its discharge shall terminate in a downward direction and at a point which will not be submerged by flood waters.

Sealing block

Further, §290.41(c)(3)(J) requires that wells have a concrete sealing block extending 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 shall be provided around the wellhead.

Securing the well head

If a wellhead is not secured properly, a pathway for pathogens may be created.

The TCEQ minimum standards describe the minimum standards for securing a wellhead, specifying that wellheads and pump bases shall be sealed by a gasket or sealing compound and properly vented to prevent the possibility of contaminating the well water [§290.41(c)(3)(K)]. More general protection is also needed, in that the area where wells are located must be secured and locked so that wells cannot be vandalized [§290.41(c)(3)(O)].

Purchased water

If a PWS does not have any purchased water interconnections, the assessor should check 'N/A' and move to the next section on the form.

Every PWS should have a sampling tap representative of each point that water enters the distribution system. This entry point should be documented in the PWS's Monitoring Plan and in SDWIS. The entry-point sample site should be clean and accessible. It is important to know the water quality entering the system, so you can tell how much it degrades over time.

If the cleanliness of the purchased source entry point (take point) is unknown, an on-site visit should be scheduled. All meter vaults, tanks, meters, and other facilities associated with a PWS interconnection should be sanitary.

Assess whether the entry point sample sites have clean, easy-to-reach sample taps so that data is accurate.

Often, purchased water sources are either assumed to be fine or blamed for all problems, without any data to prove either statement. If no data is available, it is beneficial to gather data—at least call the supplier and asked if they have had TC+ or EC+ detections recently. At best, start routinely monitoring purchased water at a point representing water immediately after the water changes hands, for example, in a meter vault. Longer term, the assessor and PWS should recognize how monitoring the water quality more closely can help them in discussions with the supplier.

Surface water

If a PWS does not have any surface intakes, they should check 'N/A' at the top and move to the next section on the form.

Surface water sources are open to the environment making them more susceptible to microbe or pathogen contamination. Treatment technique regulations ensure that these microbes and pathogens are removed and inactivated. However, a degradation in the source water can elevate the risks associated with microbes and pathogens passing through treatment and entering the distribution system.

Clearly, all surface water sources are at risk of potential sources of contamination. During the Level 1 Assessment, focus on new or changed situations that could have contributed to the TC+. Review maps, easements, and other documentation—for example, your Source Water Protection Program.

Figure 20 shows the examples of surface water intake in a lake or river.

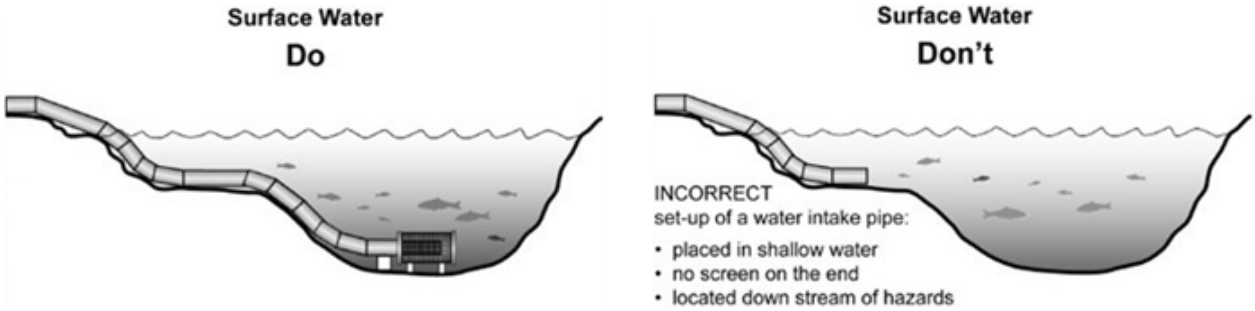


Figure 20. Example of surface water intake 'do's' and 'don't's

Just as the depth of a surface water intake is important, the location in the lake is also important. For example, an intake placed where algae blooms are common is a greater risk than one placed in a clear water area, as shown in Figure 21.

Figure 21. Example of better and worse locations for surface water intakes

Rules for surface water intakes are intended to prevent contaminants from entering the treatment plant through the intake structure. The requirements for surface water sources are in §290.41(e).

Review the regulations for setback requirements in §290.41(d). Review any TCEQ compliance documentation related to set back distances.

Documents that will be needed for this portion of the workshop may include:

- ✓ Plans or schematics for raw water intake,
- ✓ Review of potential sources of contamination in the area of the intake, and
- ✓ Documentation of how the intake should be operated—for example, how to vary the intake level.
- ✓ *Design:* Review the system's plans, specifications, and compliance documentation. Confirm that the intake meets all of the requirements in §290.41
- ✓ *Construction:* Review plans and/or other historical documentations such as Comprehensive Compliance Investigation reports to determine whether the intake was constructed as designed.
- ✓ *Operation:* Review maintenance and inspection records to confirm that the intake screens have been properly managed, and that routine inspections are performed.
- ✓ If a variable level intake structure is used, is it operated to take water from the level with the best water quality? If variable level intakes, are they being operated as intended? Has the water quality degraded due to collecting water from the intake with the poorest water quality? Has the intake been moved due to drought?

If the assessor does not have experience with surface water intakes, it is recommended that they seek expert assistance.

Questions in Section 5 of the Level 1 Assessment form

There are 3 possible answers for this section of questions: **"Yes", "No" or "N/A"**

There are no 'right or wrong' answers. The 'correct' answer is the one that you believe is most accurate and that is supported by the documentation.

If the assessor notes an inadequacy that may have resulted in the total coliform positive, this must be noted as a sanitary defect which must be documented, with its corrective action, in Section 9 of the form.

If the assessor notes an inadequacy (unrelated to any TCEQ regulations) which could cause TC+ in future, it may be noted as an additional issue. This may help in future assessments.

Table 8 describes the questions related to sources on the Level 1 Assessment form in detail.

Table 8. Questions on Section 5 of Level 1 Assessment form.

Section 5—Source questions
If more than one source is being assessed, review ALL sources when answering the questions. If any source has a sanitary defect, describe which source(s) and what the defect is in the CARP.

Section 5—Groundwater source questions	
If the PWS does not have wells, check here and skip this section:	If no wells, check here

Section 5—Groundwater well questions	Yes	No	N/A
Question 5-1. Does the PWS control and protect land within 150 feet of **each** well?	☐	☐	
5-1. Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* Possible ways that the PWS can control activities are: • By owning the land, • By having a SCE, or • By having a TCEQ-approved exception covering the area 150 feet of the assessed wells and meeting all of the conditions of that exception Review of documentation, and possibly on-site evaluation of well sites, should allow the			

Section 5—Groundwater well questions	Yes	No	N/A
Assessor to determine an answer. The TCEQ minimum standards for protection and control of the area around the wells are described in §290.41(c). The regulations focus on the area 150' from wells, but if a fecal source 151' or farther from a well is causing bacteria to enter a well (or could in future if it is not fixed), the Assessor should note that sanitary defect as part of the Level 1 Assessment. Failure to adequately install, locate, and/or maintain wells may be noted in CCI reports as a violation. **5-1. Answers** If the PWS ensures that activities around the well do not introduce fecal contaminants, and can document that, the answer is '**Yes**.' If the PWS does not have a strategy to protect and control the land around the wells, the answer would be '**No'** and a description should be given in the **CARP**.			
5-1. Rule requirement Applicable rules include: "§290.41(c)(1) Groundwater sources shall be located so that there will be no danger of pollution from flooding or from unsanitary surroundings, such as privies, sewage, sewage treatment plants, livestock and animal pens, solid waste disposal sites or underground petroleum and chemical storage tanks and liquid transmission pipelines, or abandoned and improperly sealed wells." and "§290.41(c)(1)(F) A sanitary control easement or sanitary control easements covering land within 150 feet of the well, or executive director approval for a substitute authorized by this subparagraph, shall be obtained."			
5-1. Correction options The assessor should consult with the TCEQ regarding plans for correcting sanitary defects associated with wells. If engineering or construction work is needed, the PWS should notify TCEQ of the project overview, and the TCEQ will let the PWS know whether follow up plans and specifications stamped by a Professional Engineer must be submitted.			
Well question 5-2. Does every well have a sanitary control easement (SCE) or SCE exception?	☐	☐	☐
5-2 (Well) Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* The assessor should review documentation to determine whether the PWS has the required Sanitary Control Easement with all owners, or has received TCEQ approval to operate in the absence of that protection. Note: Most SCE exceptions require that the PWS monitor well water for coliform as a condition of the approval. If this is the case, the assessor should review that data. Failure to have a Sanitary Control Easement or exception may be noted in CCI reports as a violation. The assessor should consult with the TCEQ. **5-2 (Well) Answers** If the PWS has a Sanitary Control Easement of exception, the answer is '**Yes**.' If the PWS does not have a strategy to protect and control the land around the wells, the answer would be '**No'** and a description should be given in the **CARP**. If the PWS owns all of the land within 150' and restricts activities appropriately (disallowing grazing cattle, for example) then the answer may be '**N/A'**. Consult with TCEQ to verify this.			

Section 5—Groundwater well questions	Yes	No	N/A
5-2 (Well) Rule requirement The applicable rules include: "§290.41(c)(1)(F) A sanitary control easement or sanitary control easements covering land within 150 feet of the well, or executive director approval for a substitute authorized by this subparagraph, shall be obtained. §290.41(c)(1)(F)(i) The sanitary control easement(s) secured shall provide that none of the pollution hazards covered in subparagraphs (A) - (E) of this paragraph, or any facilities that might create a danger of pollution to the water to be produced from the well, will be located thereon. §290.41(c)(1)(F)(ii) For the purpose of a sanitary control easement, an improperly constructed water well is one which fails to meet the surface and subsurface construction standards for public water supply wells. Residential type wells within a sanitary control easement must be constructed to public water well standards. §290.41(c)(1)(F)(iii) A copy of the recorded sanitary control easement(s) shall be included with plans and specifications submitted to the executive director for review. …"			
5-2 (Well) Correction options Failure to have a Sanitary Control Easement or exception may be a violation. The assessor should consult with the TCEQ. The web site for the TCEQ WSD Plan and Technical Review Section provides guidance: www.tceq.texas.gov/assets/public/permitting/watersupply/pdw/Sanitary_Control_Easement_Exception_Checklist.pdf Hazards unrelated to the presence or absence of the proper documentation should also be documented, for example as an additional issue.			
Well question 5-3. Are there known hazards within 50 - 500 feet of any well, as applicable? (~~i.e.,~~ hazards such as: septic system and related appurtenances; livestock; etc.)	☐	☐	
5-3. Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* One potential pathway for pathogens is nearby fecal matter or putrefaction. Consider whether there any known hazards close to a well. The closer it is, the greater the risk. Review the records and well maps. Review the records of TCEQ Comprehensive Compliance Investigations. Determine whether any historical issues exist. Determine whether any regulatory issues are present. Hazards near wells may be noted in CCI reports as a violation. It is highly recommended that the assessor visit each site that may have impacted the area in which TC+ was detected to verify the contents of the documentation, and to observe any changes that may have caused as-yet-unknown sanitary defects. Consider potential risks to drinking water wells from things like animal waste, sewage, spilled chemicals, etc. Fecal sources are of greatest concern, for example, • Septic tanks or fields—especially older ones; • Cattle—especially feeding operations, but also grazing; • Sewage—storage facilities or treatment facilities; • Low-lying areas—any standing water can breed pathogens; • Any other activity that could provide a source of pathogens; and • Any other hazard identified in §290.41(c); or • Any other source of fecal matter.			

Section 5—Groundwater well questions	Yes	No	N/A

5-3 (Well) Answers

If there are *no* hazards near *any* well, the answer is '**No**.'

If there are *any* hazards near *any* well, the answer would be '**Yes'** and a description should be given in the **CARP** including identification of which wells are at risk.

5-3. Rule requirements

The applicable rules include:

"§290.41(c)(1)(A) No well site which is within 50 feet of a tile or concrete sanitary sewer, sewerage appurtenance, septic tank, storm sewer, or cemetery; or which is within 150 feet of a septic tank perforated drainfield, areas irrigated by low dosage, low angle spray on-site sewage facilities, absorption bed, evapotranspiration bed, improperly constructed water well, or underground petroleum and chemical storage tank or liquid transmission pipeline will be acceptable for use as a public drinking water supply. Sanitary or storm sewers constructed of ductile iron or polyvinyl chloride (PVC) pipe meeting American Water Works Association (AWWA) standards, having a minimum working pressure of 150 pounds per square inch (psi) or greater, and equipped with pressure type joints may be located at distances of less than 50 feet from a proposed well site, but in no case shall the distance be less than ten feet.

§290.41(c)(1)(B) No well site shall be located within 500 feet of a sewage treatment plant or within 300 feet of a sewage wet well, sewage pumping station, or a drainage ditch which contains industrial waste discharges or the wastes from sewage treatment systems.

§290.41(c)(1)(C) No water wells shall be located within 500 feet of animal feed lots, solid waste disposal sites, lands on which sewage plant or septic tank sludge is applied, or lands irrigated by sewage plant effluent.

§290.41(c)(1)(D) Livestock in pastures shall not be allowed within 50 feet of water supply wells.

§290.41(c)(1)(E) All known abandoned or inoperative wells (unused wells that have not been plugged) within 1/4-mile of a proposed well site shall be reported to the commission along with existing or potential pollution hazards. These reports are required for community and nontransient, noncommunity groundwater sources. Examples of existing or potential pollution hazards which may affect groundwater quality include, but are not limited to: landfill and dump sites, animal feedlots, military facilities, industrial facilities, wood-treatment facilities, liquid petroleum and petrochemical production, storage, and transmission facilities, Class 1, 2, 3, 4, and 5 injection wells, and pesticide storage and mixing facilities. This information must be submitted prior to construction or as required by the executive director."

5-3. Correction options

Hazards near wells may cause a violation.

The assessor should consult with the TCEQ regarding planned relocation or replacement of wells or hazards. The PWS should notify TCEQ of the project overview, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted.

Hazards that are not listed in the regulations, but that could cause contamination, should also be documented—for example, as an additional issue.

Well question 5-4. Is the wellhead and pump base constructed and sealed properly to minimize contamination?	☐	☐	

5.4. Potential sanitary defect

(If more than one well is being assessed, review all wells when answering the questions.)

If a wellhead is not secured properly, a pathway for pathogens may exist. Vermin, such as insects, can enter cracks. Rain can cause contaminated water to flow through holes into the well.

The TCEQ minimum standards describe the minimum standards for securing a wellhead,

Section 5—Groundwater well questions	Yes	No	N/A
specifying that wellheads and pump bases shall be sealed by a gasket or sealing compound and properly vented to prevent the possibility of contaminating the well water. Wells with incorrectly constructed and/or sealed wellheads and/or pump bases may be noted in CCI reports as a violation. **5-4. Answers** If the wellhead and pump base are constructed properly, the answer is '**Yes'**. If not, the answer is '**No'** and the issue must be documented in the **CARP**.			
5.4. Rule requirement The applicable rules include: "§290.41(c)(3)(K) Wellheads and pump bases shall be sealed by a gasket or sealing compound and properly vented to prevent the possibility of contaminating the well water. A well casing vent shall be provided with an opening that is covered with 16-mesh or finer corrosion-resistant screen, facing downward, elevated and located so as to minimize the drawing of contaminants into the well. Wellheads and well vents shall be at least two feet above the highest known watermark or 100-year flood elevation, if available, or adequately protected from possible flood damage by levees." The area where wells are located must be secured and locked so that wells cannot be vandalized [§290.41(c)(3)(O)].			
5-4. Correction options The assessor should consult with the TCEQ regarding planned re-sealing or other construction plans, especially if this will not be done within the 30-day window. The PWS should notify TCEQ of the project overview, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted.			
Well question 5-5. Are all well casing vents and applicable air release devices covered with 16-mesh or finer screen?	☐	☐	
5.5. Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* If a well casing vents and applicable air release devices are not properly screened, a pathway for pathogens may exist. The TCEQ minimum standards describe the minimum standards for securing a wellhead, specifying that wellheads and pump bases shall be sealed by a gasket or sealing compound and properly vented to prevent the possibility of contaminating the well water. Incorrectly screened openings may be noted in CCI reports as a violation. **5-5. Answers** If the wellhead and pump base are constructed properly, the answer is '**Yes'**. If not, the answer is '**No'** and the issue must be documented in the **CARP**.			
5-5. Rule requirement The applicable rules include: "§290.41(c)(3)(K) … A well casing vent shall be provided with an opening that is covered with 16-mesh or finer corrosion-resistant screen, facing downward, elevated and located so as to minimize the drawing of contaminants into the well. …" and "§290.41(c)(3)(Q) If an air release device is provided on the discharge piping, it shall be installed in such a manner as to preclude the possibility of submergence or possible entrance of contaminants. In this respect, all openings to the atmosphere shall be covered with 16-mesh or finer, corrosion-resistant screening material or an acceptable equivalent."			

Section 5—Groundwater well questions	Yes	No	N/A
5-5. Correction options The assessor should consult with the TCEQ regarding items sanitary defects and items noted in the CCI. Screening should be simple to install, but if additional time is needed, the TCEQ must be informed, and the additional time must be requested.			
Question 5-6. Are all well blow-off lines (if provided) constructed so that the discharge will not be submerged by flood waters?	☐	☐	☐
5-6. Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* If a well blow-off lines are not properly constructed, a pathway for pathogens may exist. The TCEQ minimum standards describe the minimum standards for constructing blow-off lines to prevent the possibility of contaminating the well water. Incorrectly constructed blow-off lines may be noted in CCI reports as a violation. **5-6. Answers** If NO blow-off lines are provided at ANY wells, the answer is '**N/A'**. If ALL blow-off lines provided at ANY wells are constructed properly, the answer is '**Yes'**. If ANY blow-off lines are improperly constructed, the answer is '**No'** and the issue must be documented in the **CARP**, including an explanation of which wells have this issue.			
5-6. Rule requirement The applicable rules include: "§290.41(c)(3)(L) If a well blow-off line is provided, its discharge shall terminate in a downward direction and at a point which will not be submerged by flood waters."			
5-6. Correction options The assessor should consult with the TCEQ regarding planned relocation or replacement of blow-off lines. If this will not be completed in 30 days, a timeline must be provided The PWS should notify TCEQ of the project overview, and the TCEQ will let the PWS know whether follow up plans and specifications must be submitted, and whether the submitted timeline is acceptable.			
Question 5-7. Has an unusual raw water contamination incident or flooding incident occurred at the well site?	☐	☐	
5-7. Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* If The Assessor should determine whether any unusual raw water contamination could have occurred at a well site. If a major event happened—like a huge flood, that will be obvious. However, if the assessor is not familiar with this PWS, it may be helpful to interview operators and other staff, in case they noticed something but it seemed too insignificant to report at the time. If cameras are available, they could be reviewed. Ongoing contamination may be noted in correspondence with the TCEQ, if it reached non-compliance status. **5-7. Answers** If there was NO unusual raw water contamination incident or flooding incident that impacted ANY well, answer '**No**.' If there was unusual contamination or flooding, but it did not impact ANY well, also answer '**No**.'			

Section 5—Groundwater well questions	Yes	No	N/A
If there was an unusual raw water contamination incident or flooding incident AND it impacted ANY well, answer '**Yes**' and describe that in the **CARP**, including which wells it impacted.			
5-7.Rule requirement The rules require PWSs to provide safe water all the time—but an emergency, like a flood, can damage the PWSs ability to meet the rules.			
5-7. Correction options Unusual raw water contamination incident or flooding incidents should be discussed with the TCEQ. If damage was caused, the planned timeframe for repairing damage, and the amount of time that any sanitary defects will remain unrepaired, needs to be reviewed by the TCEQ. If repairs will take longer than 30 days, that extra time needs to be requested. The TCEQ takes security issues and extreme weather events into consideration when determining compliance during a security issue or drought, flooding, or other extreme weather event. The TCEQ will provide assistance in helping you to recover from a security issue or extreme weather event. For assistance, contact the Water Supply Division at (512) 239-4691.			

Purchased water sources

Purchased water source questions If the PWS does not purchase water, check here and skip this section:	If no purchases, check here
If more than one source is being assessed, review ALL sources when answering the questions. If any source has a sanitary defect, describe which source(s) and what the defect is in the CARP.	

Section 5—Purchased water source questions	Yes	No	N/A
Purchased-water question-1. Are all the entry point meters, vaults, and sample taps sanitary?	☐	☐	
5-1 (Purchased water) Potential sanitary defect *(If more than one purchased water source is present, assess all purchased water sources when answering these questions.)* Clean, sanitary sample sites allow collection of samples that accurately represent purchased water quality. Unsanitary sites lead to bad data. Many purchased-water systems use the first customer's tap as their entry point sample site. If this is the case, consider whether the water could degrade between the meter and that tap. If so, consider what it would take to put in a tap that better represents the quality just downstream of the meter. **5-1 (Purchased water) Answers** If the facilities associated with the interconnection between the two PWSs is sanitary, the answer is '**Yes'**. If there are concerns regarding sanitation, the answer is '**No'** and those concerns should be addressed in the **CARP**.			

Section 5—Purchased water source questions	Yes	No	N/A
5-1 (Purchased water) Rule requirements The applicable rules include §290.46(m), which requires that PWSs maintain facilities in watertight condition, and "§290.46(k) Interconnection. No physical connection between the distribution system of a public drinking water supply and that of any other water supply shall be permitted unless the other water supply is of a safe, sanitary quality and the interconnection is approved by the executive director."			
5-1 (Purchased water) Correction options If any purchased-water entry point sample tap is unsanitary it should be cleaned up. Before and after photos may be useful to document that process. If the first customer's tap is used as an entry point sample site, its adequacy at representing water quality at the point-of-purchase should be assessed. If the entry point sample site is changed, the Monitoring Plan should be revised and made available to the TCEQ upon request.			
Purchased-water question 5-2. Is the water supplier experiencing issues with coliform bacteria?	☐	☐	
5-2 (Purchased water) Potential sanitary defect *(If more than one well is being assessed, review all wells when answering the questions.)* It is recommended that, in addition to reviewing the wholesale suppliers compliance data on Texas Drinking Water Watch, that the assessor contact the seller to learn of any other issues that may not show up in the compliance database, such as low residuals or special sampling with coliform detections. If there is a significant issue within the supplier's system, it can have an adverse impact on the purchaser's water quality. For example, low residuals in the seller's water can cause low residuals in the purchaser's system, which can lead to regrowth and persistence of bacteria, causing TC+. **5-2. Answers** If the water supplier has no issues, the answer is '**No'**. If the supplier is having issues with coliform, the answer is '**Yes'** and this should be described in the **CARP**. If the supplier is having issues, but those are not represented by TC+ detections—for example, low chlorine residual—that can be documented as an additional issue.			
5-2. (Purchased water) Rule requirements The applicable rules include notification of customers by wholesalers when they have a TC+ violation, but does not require notification when there is a water quality issue that does not cause non-compliance with the TCEQ regulations. All PWSs are required to continuously meet drinking water quality standards, and in some cases upstream conditions degrade to the point where purchasers fail to meet those standards.			
5-2. (Purchased water) Correction options If the purchased water quality is monitored, and does not meet specifications, review the contract. If the contract has provisions establishing minimum quality, discuss any failures to meet those provisions with the supplier. Purchasing and redistributing drinking water will be most successful when communication between the seller and buyer is excellent. It is recommended that efforts be made to maintain this communication. If the contract does not establish the minimum water quality, consider revising it.			

Surface water sources

Surface water source questions	
If the PWS does not use surface water, check here and skip this section:	☐
If more than one source is being assessed, review ALL sources when answering the questions. If any source has a sanitary defect, describe which source(s) and what the defect is in the CARP.	

Section 5—Surface water intake questions	Yes	No	N/A

Surface intake question 5-1.

Is every surface water intake functional and operated correctly?

5-1. (Surface intake) Potential sanitary defect

(If more than one surface water intake is being assessed, review all surface water intakes when answering the questions.)

Surface water sources are open to the environment making them more susceptible to microbial or pathogenic contamination. Treatment technique regulations ensure that these microbes and pathogens are removed and/or inactivated. However, degradation in the source water can elevate the risks associated with microbes and pathogens passing through treatment and entering the distribution system.

PWSs should ensure that their raw water intake structures at surface water sources are fully functional, adequately protected, and operated in a manner to achieve optimal raw water quality conditions during variable or adverse circumstances such as drought or flooding.

PWSs should consider whether flooding, drought, sanitary sewer overflows, hazardous spills, vandalism, security breaches, or similar conditions may have caused a degradation of the source water quality to the extent that it could have adversely impacted the ability of the plant to treat water.

In addition to other concerns, recently harmful algal blooms (HABs) have been shown to be able to let very dangerous cyanotoxins into drinking water.

5-1. Answers

If the water intake has no issues, the answer is '**Yes'**.

If the intake is not operating correctly or is dysfunctional, the answer is '**No,'** and this should be described in the **CARP**. Describe any how any problem related to a surface water impact may have allowed degradation of water quality.

5-1. (Surface intake) Rule requirement

The applicable rules include:

"§290.41(e)(2) Intakes shall be located and constructed in a manner which will secure raw water of the best quality available from the source.

§290.41(e)(2)(A) Intakes shall not be located in areas subject to excessive siltation or in areas subject to receiving immediate runoff from wooded sloughs or swamps.

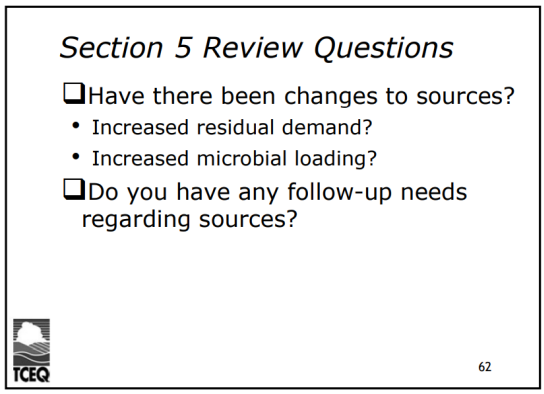
§290.41(e)(2)(B) Raw water intakes shall not be located within 1,000 feet of boat launching ramps, marinas, docks, or floating fishing piers which are accessible by the public.

§290.41(e)(2)(C) A restricted zone of 200 feet radius from the raw water intake works shall be established and all recreational activities and trespassing shall be prohibited in this area. Regulations governing this zone shall be in the city ordinances or the rules and regulations promulgated by a water district or similar regulatory agency. The restricted zone shall be designated with signs recounting these restrictions. The signs shall be maintained in plain view of the public and shall be visible from all parts of the restricted area. In addition, special buoys may be

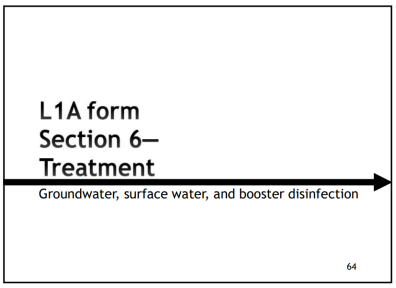
Section 5—Surface water intake questions	Yes	No	N/A
required as deemed necessary by the executive director. Provisions shall be made for the strict enforcement of such ordinances or regulations. §290.41(e)(2)(D) Commission staff shall make an on-site evaluation of any proposed raw water intake location. The evaluation must be requested prior to final design and must be supported by preliminary design drawings. Once the final intake location has been selected, the executive director shall be furnished with an original or legible copy of a United States Geological Survey 7.5-minute topographic quadrangle showing the accurate intake location. §290.41(e)(2)(E) Intakes shall be located and constructed in a manner which will allow raw water to be taken from a variety of depths and which will permit withdrawal of water when reservoir levels are very low. Fixed level intakes are acceptable if water quality data is available to establish that the effect on raw water quality will be minimal. §290.41(e)(2)(F) Water intake works shall be provided with screens or grates to minimize the amount of debris entering the plant. §290.41(e)(2)(G) Intakes shall not be located within 500 feet of a sewage treatment plant or lands irrigated with sewage effluent.”			
5-1. (Surface intake) Correction options If problems with the intake allowed degradation of water quality, it should be corrected. If a design or construction problem exists, consult with the TCEQ to discuss the extent of any needed repair work.			
Surface intake question 5-2. Has an unusual raw water contamination incident occurred at the intake site?	☐	☐	
5-2. (Surface intake) Potential sanitary defect *(If more than one surface water intake is being assessed, review all surface water intakes when answering the questions.)* Unusual water contamination incidents can be a potential pathogen risk when, for example, they cause the water to be untreatable. Changes in raw water quality that lead to sanitary defects include: –Flooding of source waters leading to very high turbidity and pathogen loads; –Extended drought leading to water near intakes becoming more and more turbid; –Changes in pH leading to failure of coagulation; –Drought followed by flood resulting in more soluble total organic carbon; –Etc. If the assessor is unfamiliar with SWTPs, it is recommended that they seek expert assistance. **5-2. Answers** If the water intake has no issues, the answer is ‘**Yes’**. If the intake is not operating correctly or is dysfunctional, the answer is ‘**No,’** and this should be described in the **CARP**. Describe any how any problem related to a surface water impact may have allowed degradation of water quality.			
5-2. (Surface intake) Rule requirement It is best practice for SWTPs to be prepared to take water of variable quality and produce water that complies with the rules in §290.111. Failure to prepare for extremes in water quality can lead to turbidity exceedances, followed by regulatory consequences.			

Section 5—Surface water intake questions	Yes	No	N/A
5-2. (Surface intake) Correction options The TCEQ takes security issues and extreme weather events into consideration when determining compliance during the event. The TCEQ may be able to provide assistance in helping PWSs recover from a security issue or extreme weather event. For assistance, contact the Water Supply Division at (512) 239-4691. PWSs should inform the TCEQ of any vandalism or other security issue.			

Before moving on to Section 6, review the questions on slide 62.



Section 6—Treatment



All water is required to be treated before it can be used as drinking water. Water in its natural environment contains pathogens that must be removed or inactivated before the water is safe for human consumption. Even groundwater usually has some pathogens—luckily for Texans, TCEQ requires that groundwater systems at least chlorinate.

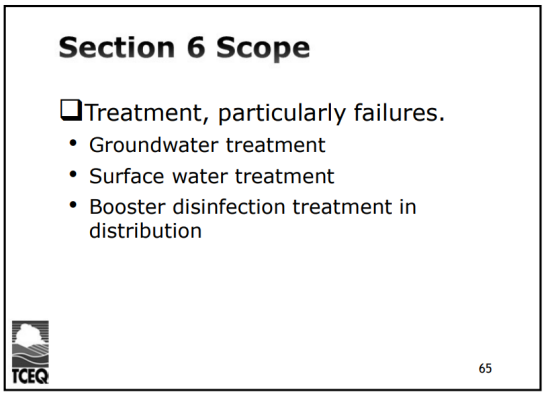
Treatment processes need to be maintained and operated correctly, or there is a potential risk that they will fail, leading to the introduction of harmful microbes and pathogens into the distribution system. For example, if you don't change the oil in an engine, it will break sooner than if you did.

Scope

Treatment impacts drinking water quality. In Texas, all water is treated before distribution. This section should consider whether treatment achieves the desired, safe, water quality

- **Groundwater treatment:** At a minimum, every well must have chlorination treatment, or chloramination. Other treatment located at a well or well field may include corrosion inhibitor addition, fluoridation, or pH adjustment.
- **Surface water treatment:** Every PWS that owns or operates a SWTP must monitor the treatment process and report data on the SWMOR. Just like groundwater systems, surface water systems may also add fluoride or corrosion inhibitors.
- **Booster disinfection treatment in distribution:** Increased attention to disinfectant residuals has caused more PWSs to install booster treatment facilities in the distribution system to maintain acceptable free chlorine or total chlorine levels. Also, aeration treatment to remove trihalomethanes may be located in distribution. This question includes assessment of all treatment facilities that could impact the area where TC+ occurred.

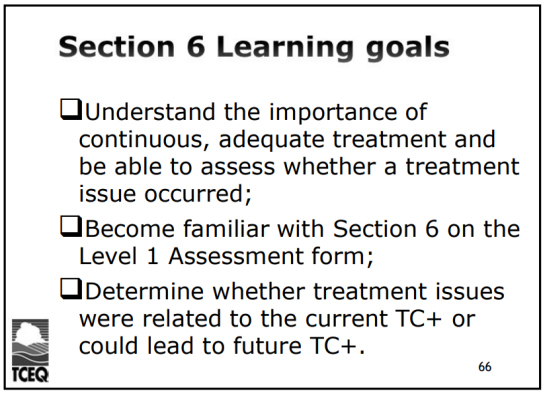
The rules for drinking water treatment plant design are in §290.42. Many of the rules for treatment plant operation are in §290.46. Treatment protocols must maintain drinking water quality within the standards of Chapter 290, Subchapter F. The rules for interconnections with other PWSs and purchased water sources are in §290.41.



Learning goals

The learning objectives for this workshop include:

- Understand the importance of continuous, adequate treatment and be able to assess whether a treatment issue occurred;
- Become familiar with Section 6 on the Level 1 Assessment form;
- Evaluate whether the water is corrosive; and
- Determine whether treatment issues were related to the current TC+ or could lead to future TC+.



Supporting documentation to review

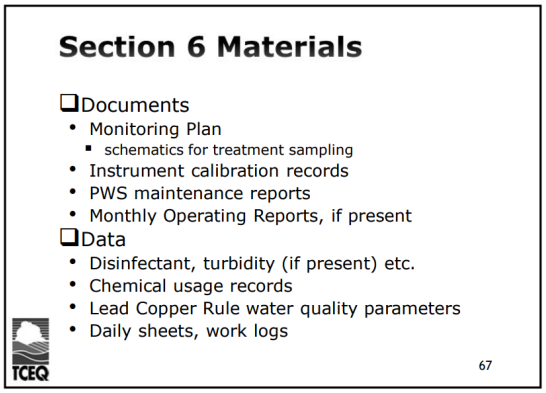
The following attachments should be reviewed during the DAM

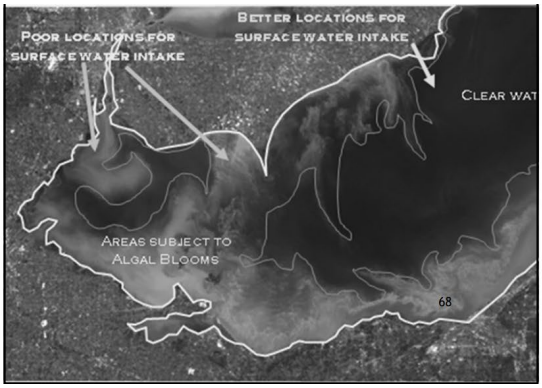
- ✓ Monitoring Plan—particularly schematics for treatment sampling,
- ✓ Disinfectant residual results, and any other water quality results that are pertinent, particularly pH, if available.

The assessor may also need to review other documents, for example:

- ✓ Chemical usage records,
- ✓ Instrument calibration records,
- ✓ Lead Copper Rule water quality parameter (WQP) monitoring results,
- ✓ PWS maintenance reports, and
- ✓ Operators' work logs.

If the assessor does not have experience with the type of treatment used at the PWS being assessed it is recommended that expert assistance be sought.





Section 6

Figure 23 shows Section 6 on the Level 1 Assessment form.

Section 6 – Treatment	Yes	No	N/A
1. Have there been any interruptions and/or changes in treatment?	☐	☐	☐
2. Are all treatment processes correctly maintained and operational?	☐	☐	☐
3. Have all surface water treatment plants (SWTP) and GUI wells met all approved concentration time (CT) and turbidity requirements, as applicable?	☐	☐	☐
4. Is all groundwater disinfected prior to distribution, and disinfection provided ahead of the water storage tank(s) if storage is provided prior to distribution?	☐	☐	☐
5. Have all wells met all 4-log inactivation requirements, as applicable?	☐	☐	☐

Figure 23. Section 6 on the Level 1 Assessment form.

Treatment assessment process: Summary

The process of assessing treatment will include:

- Review treatment records,
  - Specifically, any required monthly reports and/or
  - Chemical and water usage reports, and
  - Operator log books (if available)
- Review monitoring data,
  - Look at disinfectant data at the entry point,
  - For a SWTP, look at plant data sheets,

- Review compliance data and regulatory correspondence,
    - CCI reports will document any treatment design violations and/or additional issues,
- Interview staff to assess data reliability, and to learn about any treatment issues that are not in the information that was reviewed
- Document any sanitary defects or additional issues in the CARP.

Although there are only a few treatment questions, consider the treatment processes carefully. Treatment is required to keep the water safe, so when it fails—that is a sanitary defect.

Assess whether all treatment pumps are working correctly; whether routine maintenance has occurred and been recorded; whether flow meters for water and chemicals are reporting correctly so that chemicals can be fed correctly; whether all treatment chemical lines are free of leaks or obstructions; and whether operators look at these items daily or weekly and record their observations to catch any problems.

Look at work logs, maintenance reports, service agreements, invoices, and budgets to verify that maintenance is performed correctly.

Continuous, adequate treatment

The rules—and common sense—require that PWSs provide continuous, adequate treatment.

The treatments that are required are necessary to kill and remove germs. When treatment fails, pathogens can enter distribution causing a sanitary defect.

The questions on the form go through questions regarding whether treatment was continuous and adequate. Some other things to consider include:

- Are all required treatment units present, including redundant treatment units?
- What is the water quality data communicating?
    - Is the water corrosive?

Is redundant equipment available as required? (eg: disinfectant)?

Redundant units are required for critical treatment processes in order to avoid any interruption in treatment. This is a TCEQ requirement for treatment processes such as disinfection, coagulation, etc.

Violations of the §290.42 rules for redundant units may have been cited in recent TCEQ Comprehensive Compliance Investigations, and on-site observation can verify whether required units have been installed or repaired since the investigation. However, if changes have occurred, some violations may not yet have been documented. For example, if a pump recently broke.

If a critical treatment unit does not have a required backup, it should be corrected. The PWS or assessor should consult with the TCEQ WSD's Plan and Technical Review

Section engineers for more information regarding whether plans and specification need to be submitted. Information is available at

Is all water quality data within the system's normal ranges?

All of the documentation in reports may indicate that all systems are perfect. However, review of data may reveal a different picture.

In a complete assessment, the assessor will check for any unusual spikes or drops in any values. Sometimes, a seemingly unrelated clue solves the question of where the problem is.

The regulatory data most valuable for assessing why TC+ occurred are coliform and disinfection.

Other data that the system collects may be valuable in figuring out the reason behind the TC+. Some of the water quality data that PWSs collect, but rarely report to TCEQ, include:

- Taste,
- Smell,
- Color,
- Cloudiness or sediment in groundwater,
- Hardness,
- Alkalinity,
- pH,
- Temperature, and
- Things customers complain about, like oily feeling or burning their skin.

Other systems use additional new-fangled technology to measure:

- Geosmin,
- 2-methylisoborneol (MIB),
- Heterotrophic plate count (HPC) bacteria,
- Adenosine triphosphate (ATP),
- Quantitative polymerase chain reaction (qPCR),
- And others.

All data sources should be considered. Although correlation is not causation, sometimes events are related. For example, the first indicator of Flint, Michigan's corrosivity issues were customer complaints of bad odors and rust-colored sediment.

One technique for visualizing whether a change was 'big' or not is to graph the data over the past two months. This helps show whether a spike is unusual or not.

If there are abnormal changes in the water quality, consider whether that might be related to the TC+.

If the assessor is unfamiliar with data analysis, it is recommended that they seek expert assistance.

Is the water corrosive?

Corrosive water can cause leaks in metal pipes, valves, and solder. Water corrosivity is an underlying issue that can cause symptoms like leaks. If corrosive water is present, it may be the cause of leaks found while assessing the distribution system.

Appendix XXX provides more information on corrosivity, and how to assess whether water is corrosive using alkalinity and pH data.

Usually, corrosive water would be an issue reported during interviews with operators.

Sometimes, it can be documented in regulatory correspondence if it has caused compliance issues with the Lead and Copper Rule:

- **Large PWSs** are required to collect data for water quality parameters (WQPs), determine the optimal corrosion control treatment (OCCT) through a corrosion control study (CCS), and set optimal water quality parameters (OWQPs).
- **Small PWSs** must identify OCCT if they exceed a lead or copper Action Level. Many small PWSs use corrosion control techniques proactively, to keep the distribution pipes safe.

Other PWSs that are not required to collect WQPs can find entry point alkalinity data in any mineral sample.

The following figure shows an example of pinhole corrosion caused by corrosive water.

Figure 24. Pin-hole corrosion on a steel tank

If it is determined that corrosivity is an issue, the appropriate response could be changing pH and alkalinity, passivation, or addition of an inhibitor.

Questions in Section 6 on the Level 1 Assessment form.

There are three possible answers for this section of questions: **"Yes", "No" or "N/A"**

There are no 'right or wrong' answers. The 'correct' answer is the one that you believe is most accurate and that is supported by the documentation.

If the assessor notes an inadequacy that may have resulted in the total coliform positive, this must be noted as a sanitary defect which must be documented, with its corrective action, in Section 9 of the form.

If the assessor notes an inadequacy (unrelated to any TCEQ regulations) which could cause TC+ in future, it may be noted as an additional issue. This may help in future assessments.

The questions related to treatment are addressed in greater detail in Table 9.

Table 9. Treatment questions

Section 6—Treatment	Yes	No	N/A
Question 6-1. Have there been any interruptions and/or changes in treatment?	☐	☐	☐
6-1. Potential sanitary defect All PWSs in Texas are required to provide continuous safe water to customers. If a treatment process stops—poorly treated water can be delivered, causing a sanitary defect. Likewise, when a change is made, it can have an unintended consequence of making treatment ineffective. For examples changing the type of disinfectant or coagulant could impact how well treatment works. Changes that impact pH can cause increased corrosivity, potentially leading to degradation of pipes and appurtenance, making the system more vulnerable to contamination. If treatment is provided by the seller, the assessor should contact them to find out whether they had any interruptions or changes in treatment and when that occurred. Analysis of treated-water data may reveal variations in treated-water quality that are a symptom of an unknown interruption or change in treatment. Chemical and water usage reports may reveal issues—for example, an extended period of time when the daily chlorine use stops or is greatly less than normal. If the assessor is unfamiliar with the type of treatment present at the plant, it is highly recommended that they seek assistance from an expert on that specific treatment. **6.1. Answers** If a treatment process stopped or was changed, but it was not critical for disinfection or turbidity removal, answer **'N/A**.' For example—fluoridation. If there was NO interruption or change in any treatment, answer '**No**.' If ANY treatment processes stopped working, answer **'Yes'** and explain that in the **CARP**. If ANY treatment process was significantly changed, answer '**Yes'** and explain the change in the **CARP**.			
6-1. Rule requirements The applicable rules require continuous treatment at facilities that comply with the design, operation, and monitoring requirements of 30 TAC Chapter 290. These rules include: "§290.42(d)(1) All water secured from surface sources shall be given complete treatment at a plant which provides facilities for pretreatment disinfection, taste and odor control, continuous coagulation, sedimentation, filtration, covered clearwell storage, and terminal disinfection of the water with chlorine or suitable chlorine compounds. In			

Section 6—Treatment	Yes	No	N/A

all cases, the treatment process shall be designed to achieve at least a 2-log removal of Cryptosporidium oocysts, a 3-log removal or inactivation of Giardia cysts, and a 4-log removal or inactivation of viruses before the water is supplied to any consumer. The executive director may require additional levels of treatment in cases of poor source water quality. Based on raw water monitoring results, the executive director may require additional levels of treatment for Cryptosporidium treatment as specified in §290.111 of this title."

And:

"§290.42(e)(1) All water obtained from surface sources or groundwater sources that are under the direct influence of surface water must be disinfected in a manner consistent with the requirements of §290.110 of this title (relating to Disinfectant Residuals).

§290.42(e)(2) All groundwater must be disinfected prior to distribution. The point of application must be ahead of the water storage tank(s) if storage is provided prior to distribution. Permission to use alternate disinfectant application points must be obtained in writing from the executive director.

§290.42(e)(3) Disinfection equipment shall be selected and installed so that continuous and effective disinfection can be secured under all conditions."

And:

"§290.46(d) Disinfectant residuals and monitoring. A disinfectant residual must be continuously maintained during the treatment process and throughout the distribution system.

§290.46(d)(1) Disinfection equipment shall be operated and monitored in a manner that will assure compliance with the requirements of §290.110 of this title (relating to Disinfectant Residuals).

§290.46(d)(2) The disinfection equipment shall be operated to maintain the following minimum disinfectant residuals in each finished water storage tank and throughout the distribution system at all times:

§290.46(d)(2)(A) a free chlorine residual of 0.2 milligrams per liter (mg/L); or

§290.46(d)(2)(B) a chloramine residual of 0.5 mg/L (measured as total chlorine) for those systems that distribute chloraminated water."

6-1. Correction options

The Assessor should consult with the TCEQ regarding appropriate corrective actions. If a major treatment failure occurred, and additional time is required, it may be necessary to request more time to complete repairs.

If treatment failure led to an absence of disinfectant residual, the PWS may need to issue a precautionary 'boil water notice.'

If the treatment process that stopped working was related to disinfection or turbidity removal, a PWS has only 5 days to initiate repairs or equipment replacement.

If problems with treatment allowed degradation of water quality, they should be corrected. If a design or construction problem exists, consult with the TCEQ to discuss the extent of the needed work to determine if plans and specifications must be submitted.

Question 6-2. Are all treatment processes correctly maintained and operational?	☐	☐	☐

6-2. Potential sanitary defect

Treatment processes need to be maintained and operated, or there is a potential risk that they will fail, leading to the introduction of harmful microbes and pathogens into the distribution system—which is a sanitary defect.

If treatment processes are not maintained and operational, issues may have been noted in the TCEQ's investigations. The assessor should look at the most recent CCI report.

Review of recent water quality data may reveal unknown issues with operability of treatment. Chemical and water usage reports may reveal issues.

Section 6—Treatment	Yes	No	N/A

6-2. Answers

If the PWS being assessed does not operate any treatment process **'N/A'** would be a correct answer.

If all treatment processes were operating correctly and were well maintained, answer '**Yes**.' If not, answer '**No'** and describe in **CARP**.

Rule requirement

The applicable rules include

"§290.46(m) Maintenance and housekeeping. The maintenance and housekeeping practices used by a public water system shall ensure the good working condition and general appearance of the system's facilities and equipment. The grounds and facilities shall be maintained in a manner so as to minimize the possibility of the harboring of rodents, insects, and other disease vectors, and in such a way as to prevent other conditions that might cause the contamination of the water. …

§290.46(m)(2) When pressure filters are used, a visual inspection of the filter media and internal filter surfaces shall be conducted annually to ensure that the filter media is in good condition and the coating materials continue to provide adequate protection to internal surfaces.

§290.46(m)(3) When cartridge filters are used, filter cartridges shall be changed at the frequency required by the manufacturer, or more frequently if needed.

§290.46(m)(4) All water treatment units, storage and pressure maintenance facilities, distribution system lines, and related appurtenances shall be maintained in a watertight condition and be free of excessive solids.

§290.46(m)(5) Basins used for water clarification shall be maintained free of excessive solids to prevent possible carryover of sludge and the formation of tastes and odors.

§290.46(m)(6) Pumps, motors, valves, and other mechanical devices shall be maintained in good working condition.

§290.46(m)(7) Reverse osmosis or nanofiltration membrane systems shall be cleaned, or replaced, in accordance with the allowable operating conditions of the manufacturer and shall be based on one or more of the following: increased salt passage, increased or decreased pressure differential, and/or change in normalized permeate flow."

6-1. Correction options

If problems with the treatment maintenance or operability allowed degradation of water quality, that should be corrected. If a design or construction problem exists, consult with the TCEQ to discuss the extent of any needed correction.

Question 6-3. Have all surface water treatment plants (SWTP) and GUI wells met all approved concentration time (CT) and turbidity requirements, as applicable?	☐	☐	☐

6-3. Potential sanitary defect

SWTPs and some other treatment plants are assigned site-specific CT requirements because the raw water is known to potentially contain pathogens—like all surface water and some wells. If they don't meet the CT requirements, pathogens can enter the distribution system, causing a sanitary defect.

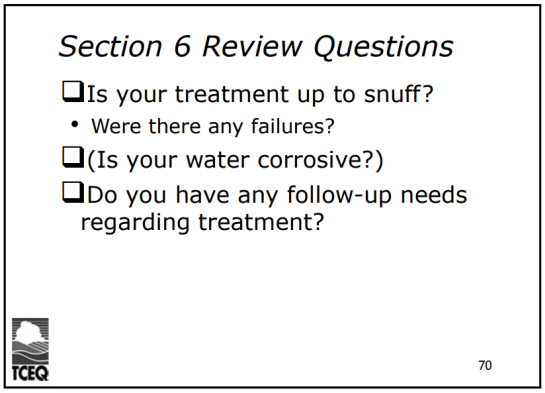
These plants will have regulatory correspondence in the form of a CT study approval letter that the assessor must review to determine if inactivation (CT) was successful. The assessor should look at data going back at least the two months up to present.

The reports that summarize daily compliance are the SWMORs for SWTPs and groundwater reports for GUIs. The assessor should review these reports to see if there are any issues. Then, data sources like turbidimeters and residual analyzers should be

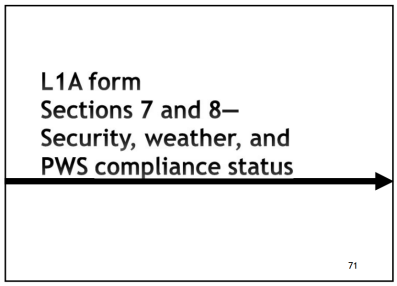
Section 6—Treatment	Yes	No	N/A
evaluated to determine if that data is reliable or not. Prior issues regarding any failure to meet CT and turbidity requirements may be documented in regulatory correspondence. **6-3. Answers** If the PWS being assessed does not operate a SWTP (or GUI plant) answer **'N/A.'** If the PWS has a SWTP, and if the CT requirements were met continuously during this period, answer **'Yes.'** If the PWS has a SWTP (or GUI plant), but it did not meet CT requirements at any point during this period, answer '**No**' and explain that in the CARP.			
6-3. Rule requirement The applicable rules include the turbidity removal and inactivation treatment technique requirements, for example: "§290.111(c) Treatment technique requirements. A system that treats surface water or groundwater under the direct influence of surface water must meet minimum treatment technique requirements before the water reaches the entry point to the distribution system. §290.111(c)(1) The combination of pathogen removal and disinfection processes used by a public water system must achieve at least a 4.0-log removal/inactivation of viruses. §290.111(c)(2) The combination of pathogen removal and disinfection processes used by a public water system must achieve at least a 3.0-log removal/inactivation of Giardia lamblia. §290.111(c)(3) A public water system that is required by subsection (b) of this section to conduct raw surface water monitoring must comply with the requirements of this paragraph."			
6-3. Correction options If a design or construction problem exists, consult with the TCEQ to discuss the extent of any needed repair work. If review of recent data shows any issues meeting CT, consider what changes to disinfection protocols are needed. Consult with the TCEQ to regarding an updated CT Study, if needed.			
Question 6-4. Is all groundwater disinfected prior to distribution, and disinfection provided ahead of the water storage tank(s) if storage is provided prior to distribution?	☐	☐	☐
6-4. Potential sanitary defect All well water is likely to contain viruses, if not other pathogens, which can cause a sanitary defect if bacteria get into the distributed water. Therefore, chlorine should be in contact with the water long enough to kill bacteria and viruses before it gets to the first customer. If chlorine application is not before storage, the PWS should have regulatory documentation establishing TCEQ's requirement for approving that. If residuals are low, or other concerns exist, the assessor may wish to evaluate the amount of CT provided by plant piping during the TC+ incident. In the absence of other data, chemical and water usage data can be helpful in determining chlorine application rates in this situation. **6-4. Answers** If the PWS has no wells and does not treat any groundwater, the answer is '**N/A'**. If the PWS's well water goes to storage before distribution, answer **'Yes.'** If not, answer '**No'**, explain that in the CARP.			

Section 6—Treatment	Yes	No	N/A
6-4. Rule requirement The applicable rules include "§290.42(e)(2) All groundwater must be disinfected prior to distribution. The point of application must be ahead of the water storage tank(s) if storage is provided prior to distribution. Permission to use alternate disinfectant application points must be obtained in writing from the executive director."			
6-4. Correction options If a design or construction problem exists, consult with the TCEQ to discuss the extent of any needed repair work. If possible, best practice would be to re-route piping to allow the disinfectant time to inactivate (kill) pathogens. The assessor should consult with the TCEQ regarding options.			
Question 6-5. Have all wells met all 4-log inactivation requirements, as applicable?	☐	☐	☐
6-5. Potential sanitary defect Review well records to determine whether or not any wells at the PWS are required to have 4-log viral inactivation. The assessor can verify this on Texas Drinking Water Watch. Only about 30 PWSs in Texas have this requirement. If 4-log is required, are the facilities for disinfection treatment in good operating order and sized properly? Are any parts broken? **6-5. Answers** If the PWS does not have wells that have 4-log viral inactivation, the correct answer is **'N/A.'** If the PWS has wells that have 4-log viral inactivation, and met treatment requirements, answer **'Yes.'** If the PWS has wells that have 4-log viral inactivation, and the treatment broke, hiccupped, or was otherwise imperfect, answer **'No'** and explain that in the CARP, or if the problem did not cause a violation, describe it as an additional issue.			
Rule requirement The applicable rules include: "§290.116(a) Applicability. All groundwater public water systems, including such systems that use surface water or groundwater under the direct influence of surface water (mixed systems), must comply with one or more of the treatment techniques and corrective actions of this section if a raw groundwater source sample was positive for fecal indicators, if a significant deficiency was identified, or if the system is not required to conduct raw groundwater source monitoring because it provides at least 4-log treatment of viruses at each groundwater source."			
6-1. Correction options If treatment was unreliable, and was not continuously providing 4-log viral inactivation, it would be necessary to repair or correct any insufficiently sized or inoperable treatment processes or equipment. The assessor should consult with TCEQ.			

Before moving on, review the questions shown on slide 70.



Sections 7 and 8—Security, weather, and PWS compliance status



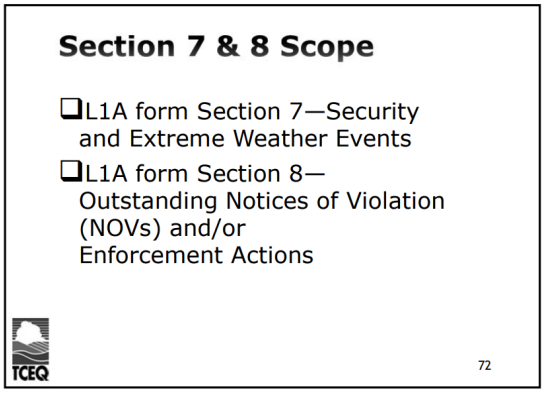
Note: during the DAM, Sections 7 and 8 will be discussed together.

Scope

This section covers the next section of the Level 1 Assessment form:

- Section 7: Security and Extreme Weather Events
- Section 8: Outstanding Notices of Violation (NOVs) and/or Enforcement Actions

Questions in this section apply to all PWSs.

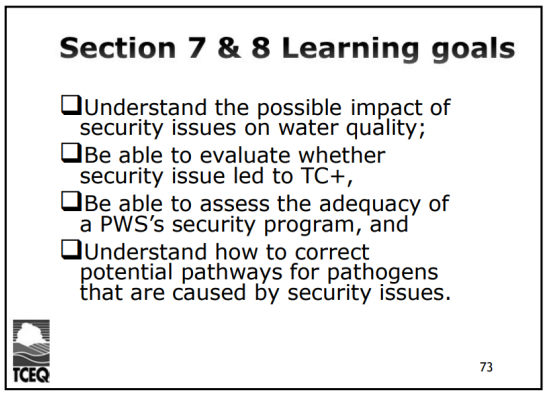


Learning goals

These questions are intended to help you assess the risk of security issues, and whether they may have led to a TC+.

The learning objectives for this workshop include:

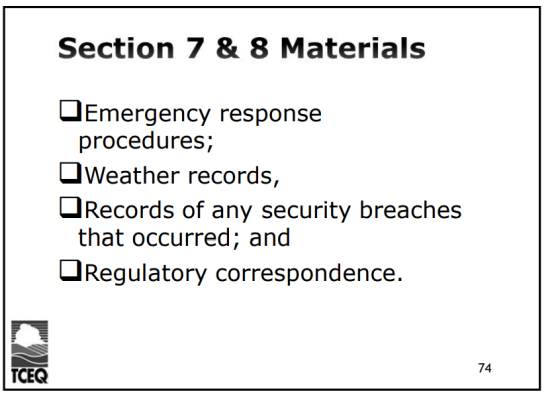
- Understanding the possible impact of security issues on water quality;
- Being able to evaluate whether security issue led to TC+,
- Being able to assess the adequacy of a PWS's security program, and
- Understanding how to correct potential pathways for pathogens that are caused by security issues.



Supporting documentation

Documents the assessor may find helpful include the PWS's:

- ✓ Emergency response procedures;
- ✓ Weather records,
- ✓ Records of any security breaches that occurred; and
- ✓ Regulatory correspondence.



Section 7

Figure 25 shows the Section 7—Security and Extreme Weather Event on the Level 1 Assessment form.

Section 7 – Security and Extreme Weather Event	Yes	No	N/A
1. Were all water treatment plants and all appurtenances, raw water pump stations, water storage tanks, and wells enclosed by an intruder-resistant fence or enclosed in a lockable building, as applicable?	☐	☐	☐
2. Did any security breaches or vandalism occur in the PWS near the time of the total coliform-positive (TC+) sample?	☐	☐	
3. Did any extreme weather occur around the time of the positive samples?	☐	☐	

Figure 25. Section 7—Security and Extreme Weather Event

Section 8

Figure 26 shows Section 8 of the Level 1 Assessment form.

Required Additional Information and Attachments

Section 8 – Outstanding Notice of Violations (NOV) and/or Enforcement Actions	Yes	No
1. Is the PWS under some other Compliance Schedule for anything related to the event that triggered the assessment?	☐	☐
If yes, describe:		

Figure 26. Section 8 of the Level 1 Assessment form.

Section 8 also included the check boxes for the two required attachments.

Assessment process for Section 7

If there was any sort of security incident, it likely to be one of the top items of conversation at the PWS, so it should not be super difficult to assess, even if the assessor is unfamiliar with the PWS.

The process of assessing security incidents will include:

- Interview operators and/or managers regarding any security incidents
  - If an incident occurred, follow up with emergency responders, as needed,
- Assess whether the incident impacted PWS operations or facilities, and
- Document any issues.

Security

Security breaches can have an impact on PWS operations; this workshop will talk about how that could happen.

Examples include:

- Teenagers climbing an elevated storage tank and leaving a hatch open, so that rain, birds, and other varmints can enter and contaminate stored water.
- Vandals stealing chlorine cylinders without detection, allowing un-disinfected water to be produced.
- Open gates allowing livestock to enter the area surrounding a well or underground clearwell, allowing potential fecal contamination.
- Intentional contamination of drinking water.

Every PWS has a responsibility to provide continuous and adequate water to their customers, which means preparing for potential security issues. Therefore, securing the facilities ensures that the public won't lose water to a security issue or other emergency event.

Security breaches are rare, because PWSs generally protect against them.

Very small PWSs are often located at businesses, where the security procedures are driven by protection of other assets, like the cash register. Large community PWSs generally have formal procedures for responding to a security breach, for example, calling the local police or sheriff department. In any case, all PWSs must inform the TCEQ of security breaches related to the drinking water infrastructure.

When a security breach occurs, it should be described in the CARP.

Often, a security breach may be related to answers in other sections of the Level 1 Assessment form. For example, in the case of vandals stealing chlorine cylinders, the interruption in treatment would also be noted in Section H: Treatment.

Security breaches are rare and unique. The way to make sure that they don’t happen twice depends on what happened. Therefore, the correction options will be very specific to the event.

Some general correction options include:

- Ensure vandalism warning signs are posted at every well site and water treatment facility;
- Ensure that fences don’t have gaps or hole;
- If cameras are present, make sure they are maintained and operated correctly;
- Make sure that gates are locked when staff are not on-site;
- Include instructions for responding to security breaches in operator training; and
- Have and use an up-to-date emergency response plan.

Emergency response

Not every PWS is required by the TCEQ to have an emergency response plan. However, it is a general best practice for any business or community to be prepared for security breaches and other emergencies by having some kind of emergency response plan. For example, fire codes require all buildings to have signs showing fire evacuation procedures.

When a security breach occurs, it is important for staff to know what to do—and for managers to be able to evaluate whether proper follow-up actions were taken.

An emergency response plan is a useful tool to address and correct security vulnerabilities when identified. Vandalism warning signs should be posted at every well site and water treatment facility.

If an emergency happened, it may be a 'wake-up call' to create, revise, or implement an emergency response plan to incorporate lessons learned from a security breach.

Some considerations when implementing an emergency response plan include:

- Evaluate the adequacy of security facilities like fences, gates, locks, etc.
- Evaluate the adequacy of emergency response preparations and determine whether the operators and managers have information needed to follow up on any security breaches.
- Determine whether a security breach could lead to the TC+.

Questions in Section 7

Table 9 shows the questions in Section 7 of the Level 1 Assessment form.

Table 9. Questions in Section 7

Section 7 – Security and Extreme Weather Event	Yes	No	N/A
Question 7-1. Were all water treatment plants and all appurtenances, raw water pump stations, water storage tanks, and wells enclosed by an intruder-resistant fence or enclosed in a lockable building, as applicable?	☐	☐	☐
7-1. Potential sanitary defect If the system's facilities are not secure, they are vulnerable to intentional or unintentional contamination, and that is a sanitary defect. If facilities that are required to be enclosed and locked, it may be noted in TCEQ investigation reports. If the assessor is unfamiliar with the PWS being assessed, it is recommended that the assessor gather information from PWS staff. On-site inspections may be needed if other documentation is not available. **7-1. Answers** If the PWS *does not have* ANY water treatment plants, appurtenances, raw pump station, storage tanks, or wells, the correct answer is **'N/A.'** If the PWS has ANY of these facilities, and they *are* ALL enclosed by an intruder-resistant fence or enclosed in a lockable building, answer **'Yes.'** If the PWS has ANY of these facilities, and ANY of them *are not* enclosed by an intruder-resistant fence or enclosed in a lockable building, answer **'Yes.'** and explain that in the CARP, or if the problem did not cause a violation, describe it as an additional issue.			
7-1. Rule requirement The applicable rules include: "§290.38(39) Intruder-resistant fence--A fence six feet or greater in height, constructed of wood, concrete, masonry, or metal with three strands of barbed wire extending			

Section 7 – Security and Extreme Weather Event	Yes	No	N/A
outward from the top of the fence at a 45 degree angle with the smooth side of the fence on the outside wall. In lieu of the barbed wire, the fence must be eight feet in height. The fence must be in good repair and close enough to surface grade to prevent intruder passage." "§290.41(c)(3)(O) All completed well units shall be protected by intruder-resistant fences, the gates of which are provided with locks or shall be enclosed in locked, ventilated well houses to exclude possible contamination or damage to the facilities by trespassers. The gates or wellhouses shall be locked during periods of darkness and when the plant is unattended." "§290.41(e)(5) The raw water pump station and all appurtenances must be installed in a lockable building that is designed to prevent intruder access or enclosed by an intruder-resistant fence with lockable gates." "§290.42(m) Security. Each water treatment plant and all appurtenances thereof shall be enclosed by an intruder-resistant fence. The gates shall be locked during periods of darkness and when the plant is unattended. A locked building in the fence line may satisfy this requirement or serve as a gate." "§290.43(e) Facility security. All potable water storage tanks and pressure maintenance facilities must be installed in a lockable building that is designed to prevent intruder access or enclosed by an intruder-resistant fence with lockable gates. Pedestal-type elevated storage tanks with lockable doors and without external ladders are exempt from this requirement. The gates and doors must be kept locked whenever the facility is unattended."			
7-1. Correction options The PWS should ensure that the system is secure against intrusion. If construction or repair activities will be undertaken in order to correct issues, the assessor should consult with TCEQ to determine whether that is extensive enough to need submittal of plans and specifications.			
Question 7-2. Did any security breaches or vandalism occur in the PWS near the time of the total coliform-positive (TC+) sample?	☐	☐	
7-2. Potential sanitary defect Security breaches or vandalism may lead to system vulnerability, contamination, and sanitary defects. If the assessor is not familiar with the PWS, they should interview system staff to find out if there were security breaches or vandalism. If an incident did occur, the assessor needs to evaluate whether it caused a sanitary defect, and whether it is ok now. **7-2. Answers** If NO security breach or vandalism occurred during this time period, answer **'No.'** If a security breach or vandalism incident occurred, answer **'Yes'** and explain that in the **CARP**, or if the problem did not cause a violation, describe it as an additional issue.			
7-2. Rule requirement The applicable rules include those listed under question 7-1, above. A PWS must ensure that they produce safe water continuously—allowing security breaches or vandalism can lead to an inability to accomplish that goal.			
7-2. Correction options If a security breach or vandalism incident occurred, the assessor should consult with TCEQ.			

Section 7 – Security and Extreme Weather Event	Yes	No	N/A
Question 7-3. Did any extreme weather occur around the time of the positive samples?	☐	☐	
7-3. Potential sanitary defect Extreme weather may lead to system vulnerability, contamination, and sanitary defects. If the assessor is not familiar with the PWS, they should interview system staff to find out if there were extreme weather events during the time period. If an event did occur, the assessor needs to evaluate whether it caused a sanitary defect, and whether any damage has been addressed. **7-3. Answers** If the PWS NO security breach or vandalism occurred during this time period, answer **'No.'** If a security breach or vandalism incident occurred, answer **'Yes'** and explain that in the **CARP**, or if the problem did not cause a violation, describe it as an additional issue.			
7-3. Rule requirement The applicable rules include			
7-3. Correction options If treatment was unreliable, and was not continuously providing 4-log viral inactivation, it would be necessary to repair or correct any insufficiently sized or inoperable treatment processes or equipment. The assessor should consult with TCEQ.			

Assessment process for Section 8—Compliance status

Section 8 of the Level 1 Assessment form asks about the system's compliance status.

This is one of the first things that people consider when a Level 1 Assessment is triggered. The question always comes up: "Did we know about this issue before?" both at the PWS and at TCEQ.

It seems like a PWS should instantly know the answer to this, but that is not necessarily true. For example, when a senior, knowledgeable person retires, they take some knowledge with them. Or, when a PWS switches from one contract operator to a different one. Or, when the records warehouse burns down. In that kind of situation, the assessor needs to double check the PWS's compliance status.

The assessor should:

- Consult with TCEQ Enforcement Division and ask if they have any open Agreed Orders with the PWS, and
- Consult with the local TCEQ Regional Office to see if there are any investigation reports that document violations and/or additional issues; and
- Consult with the TCEQ Water Supply Division RTCR program to coordinate coliform compliance.

It seems like a lot of people to talk to, but Level 1 Assessments are important, and the quick turnaround means that an extra level of communication, coordination, and cooperation is needed to be successful.

The system's compliance status may impact what actions the PWS can take—specifically, a PWS that has triggered a previous Level 1 Assessment in the prior 12 months must have someone perform a Level 2 Assessment, which is very different than the Level 1 Assessment.

Section 8 of the Level 1 Assessment form is shown in Table 10.

Table 10. Section 8 of the Level 1 Assessment form.

Section 8 – Outstanding Notice of Violations (NOV) and/or Enforcement Actions	**Yes**	**No**
Question 8-1. Is the PWS under some other Compliance Schedule for anything related to the event that triggered the assessment?	☐	☐
If yes, describe:		

The answer to Question 8-1 is simple, after talking to TCEQ. However, the description may be more complicated. A person can be in the water business a long time without ever having to deal with an Enforcement issue—very few people are experts on not complying with the rules, thank heavens! But that makes it all the more important to get expert help.

Describing other Compliance Schedules

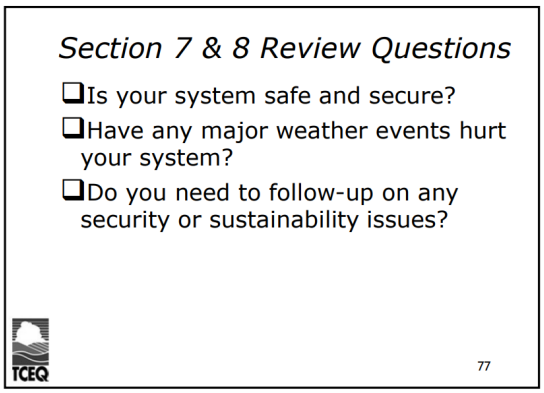
If the system is under a compliance schedule for a related issue, that needs to be described. The description should be as clear and brief as possible, without leaving anything out.

If the system does not have the records to write the description, contact the TCEQ to get copies.

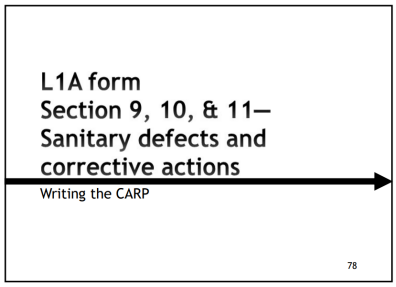
Describe:

- What the other compliance schedule is related to, for example:
  - Previous Level 1 Assessment,
  - Previous Level 2 Assessment,
  - Comprehensive Performance Evaluation,
  - Agreed Order, etc.;
- What violation(s) and/or enforcement actions that compliance schedule was related to;
- The technical requirements and deadlines,
- TC+

Before moving on, discuss the review questions shown on slide 77.



Section 9, 10, & 11—
Sanitary defects and corrective actions



This workshop switches gears.

Sections 1 through 7 on the Level 1 Assessment form went through the questions one-by-one, and talked about the process of assessing the facilities and procedures at the PWS.

In this workshop, we start to wrap it up and create the CARP.

Scope

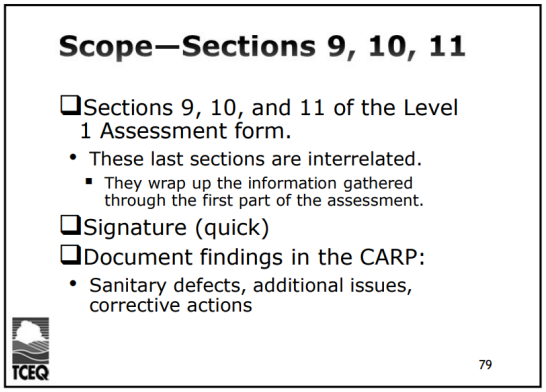
This section covers the next three sections of the Level 1 Assessment form. These last sections are interrelated. They wrap up the information gathered through the first part of the assessment.

First—the signature item goes back to the discussion in Workshop 1 about who was going to sign the form representing the system.

- **Section 10—Signature**
  - This section is where the assessor and PWS are requested to provide contact information, and where a PWS representative signs the form.

Then—the main part of this workshop—Sections 9 and 10 make up the CARP, which is what will receive the greatest scrutiny.

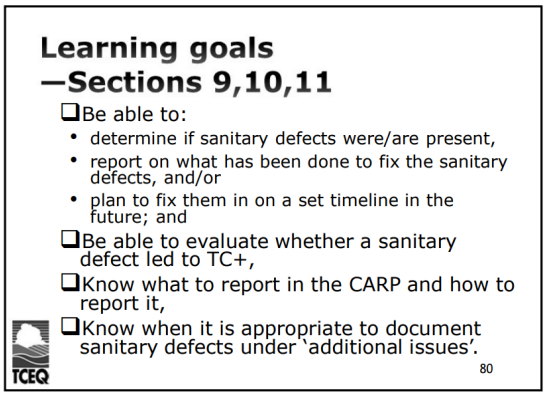
- **Section 9—Sanitary Defects (SD) and Corrective Actions (CA)**
  - This section is where the assessor lists sanitary defects found during the process of going through the form, and describes how the PWS corrected them or will correct them.
- **Section 11—Additional Issue Description and Comments–(Optional)**
  - If the Level 1 Assessment finds sanitary defects that are not specifically related to compliance with the TCEQ's rules and regulations, the PWS has the option to note those on the Level 1 Assessment form.



Learning goals

The learning objectives for this workshop include:

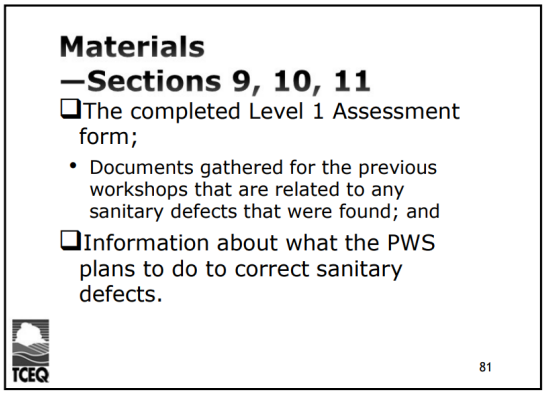
- Be able to
  - determine if sanitary defects are present,
  - report on what has been done to fix the sanitary defects, and/or
  - plan to fix them in on a set timeline in the future; and
- Be able to evaluate whether a sanitary defect led to TC+,
- Know what to report in the CARP and how to report it,
- Know when it is appropriate to document sanitary defects under 'additional issues'.



Supporting documentation

Documents the assessor will find helpful include:

- ✓ The completed Level 1 Assessment form;
- ✓ Documents gathered for the previous workshops that are related to any sanitary defects that were found; and
- ✓ Information about what the PWS plans to do to correct sanitary defects.



Section 10

Figure 27 shows Section 10—Signature on the Level 1 Assessment form.

Signature and Contact Information

Section 10 – Signature. ***Please provide the Assessor and PWS Representative's contact information.***		
Level 1 Assessor	Name *(please print)*	
	Title	
	Phone Number	( )
	Email	
PWS Representative	Name *(please print)*	
	Title	
	Phone Number	( )
	Email	
"I certify under penalty of law that I have personally examined and am familiar with the information submitted and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."		
PWS Representative Signature:_____ Date:____/____/____/		

Figure 27. Section 10—Signature on the Level 1 Assessment form.

Sections 9 and 11

Figures 28 through 31 show Sections 9, the instructions for Section 9 and Section 11, respectively. These sections are related, in that they require writing a narrative of what was found and what was corrected.

Section 9 – Sanitary Defects (SD) and Corrective Actions (CA)		
Did the PWS identify any Sanitary Defects in Section 1 – 7 of the assessment form?	**Yes** ☐	**No** ☐
If **No**, move to **Section 10** and complete the **Signature and Contact Information** page. If **Yes**, describe any SD(s) and associated CA(s) in the below spaces.		

Figure 28. Section 9 on the Level 1 Assessment form.

Figures 29 shows the instructions for Section 9.

Describe any SD identified in Section 1 – 7 and list the associated CA

- The PWS is responsible for submitting compliance documentation or proof (supporting documents, photographs, etc.) that any **CA** was completed within the required **30 day compliance deadline** for completing the Level 1 assessment and submitting the completed Level 1 assessment form to the TCEQ. At any time during the Level 1 assessment or corrective action phase, either the PWS or the TCEQ may request a consultation with the other party to determine the appropriate actions. The PWS shall consult with the TCEQ on all relevant information that may impact its ability to comply with the Level 1 assessment and **CA** requirements.
- If the PWS has not completed any **CA** by the time of submission of the assessment form, the PWS must complete any **CA** in compliance with a timetable (compliance deadline) approved by the TCEQ after consultation with the TCEQ.
- Please specify the Section number **(Section 1 – 7)** that that the **SD** is associated with in the Level 1 assessment checklist.
- Please indicate the completion status for any required **CA.**
- If any **CA** has not been completed within the **30 day compliance deadline,** please specify a **Proposed Compliance Deadline. The TCEQ must approve any Proposed Compliance Deadline**.

Figure 29 Instructions for Section 9 on the Level 1 Assessment form.

Figures 30 shows the area in Section 9 where corrective actions related to sanitary defects must be described.

Section No.	Sanitary Defect (SD) and associated Corrective Action (CA)				
SD					
CA					
	CA Completed?	Yes ☐	No ☐	If "No", please indicate Proposed Compliance Deadline	

Figure 30. Section 9—CARP Items on the Level 1 Assessment form.

Figures 31 shows Section 11 where corrective actions related to additional issues may be described.

Additional Issue Description and Comments

Section 11 – Additional Issue Description and Comments – (Optional)	
PWSs may provide additional information in this section to further describe any issues and/or potential causes of contamination which may have contributed to any identified sanitary defects.	
1	**Area-of-Impact:**
	Issue Description:

Figure 31. Section 11—Additional Issue Description and Comments on the Level 1 Assessment form.

Section 10—Signature

This section is where the assessor and PWS are requested to provide contact information, and where a PWS representative signs the form. The assessor should:

- Be able to identify who can sign the form;
- Be aware of the TCEQ's data for PWS points-of-contact and understand the PWS's responsibility for updating it;

The PWS is responsible for submitting compliance documentation or proof (supporting documents, photographs, etc.) that any CA was completed within the required 30 day compliance deadline for completing the Level 1 assessment and submitting the completed Level 1 assessment form to the TCEQ. At any time during the Level 1 assessment or corrective action phase, either the PWS or the TCEQ may request a consultation with the other party to determine the appropriate actions. The PWS shall consult with the TCEQ on all relevant information that may impact its ability to comply with the Level 1 assessment and CA requirements.

Therefore, a representative of the PWS should sign the form.

It is recommended that a sufficiently senior staff person or manager is signing the form, and is aware of the potential need to fix sanitary defects.

If the form will be routed through a large organization, determine if the chain-of-communication supports the urgency of sending it in within 30 days.

Data in Texas Drinking Water Watch

The individual identified by the TCEQ as the 'Administrative Contact' for the PWS may want to sign the form. This person is listed in the TCEQ's Texas Drinking Water Watch (DWW) database. Check and update the TCEQ's data, which is on the web at:

dww2.tceq.texas.gov/DWW/

Responsibility of signer

The form includes the following statement before the signature line:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Sections 9 and 11: Findings

This is the part where you take the results of the analysis you have performed as you went through the form, and synthesize them into the report and submittal to TCEQ.

Sanitary Defects

This section is where the assessor lists sanitary defects found during the process of going through the form, and describes how the PWS corrected them or will correct them.

While going through Sections 1 through 8 of the form, the assessor identifies issues that might be sanitary defects. Some of those may be significant, some may have actually led to the TC+ issue.

However, the forensic analysis of TC+ occurrence in drinking water distribution system is complex, and not always successful. Because of the delay in getting results back from the lab, the water that we identify as having bacteria has already gone down the pipe—we are always chasing yesterday's water.

Therefore, it is possible that the assessor was unable to identify the sanitary defect that led to the TC+.

That being said, it is not that unlikely that an assessor can find issues that could, in future, cause TC+. It is not unusual for a PWS to need to develop a coliform sample collection SOP, for example.

On the one hand, an assessor may be glad if they find no sanitary defects—however, not 'finding' a sanitary defect does not mean it is not there, just waiting to cause trouble again. If a PWS triggers a second Level 1 Assessment in a 12 month period, the next step is a Level 2 Assessment, which is more in-depth.

This Section asks the Assessor to consider whether any of the findings described in the first portions of the assessment could be a potential pathway for pathogens. Since the concept of keeping bacteria out of the water is fundamental to many best practices and rules, it is reasonable to expect that if any problems were found—they may be sanitary defects. All of the questions are intended to lead the Assessor to find sanitary defects, if present.

Ultimately, it is a sanitary defect if:

- It lets microbes get into otherwise protected source water, like wells;
- It interferes with treatment, particularly disinfection and turbidity removal;
- It allows backflow or backsiphonage to occur;
- It allows stagnant water, since seed microbes are always present;
- It causes excessive water age, same reason; and
- Anything else that fits.

Sometimes, the Assessor won't find any sanitary defects, as recognized by EPA:

- EPA Guidance states:

  "Identifying and correcting sanitary defects early will provide some assurance that issues have been addressed that may compromise public health. While the Level 1 assessment is intended to be a basic and relatively simple assessment, it should be conducted thoroughly enough to capture the possibility that there may be multiple sanitary defects. In some cases, however, a sanitary defect may not be found despite conducting a thorough assessment."

Did you find any sanitary defects?

A sanitary defect is defined as a potential pathway for pathogens. It may be a physical problem—like a cross connection, or a programmatic problem—like not having a coliform sample collection SOP.

The Assessor should consider any items that were documented in the answers to Sections A through M. If unsanitary conditions were present—that could be a sanitary defect.

Did a sanitary defect that you found cause the TC+(s)?

In most cases, by restricting the scope of the area assessed, any physical sanitary defects that are related to the TC+ will be identified.

This can be straightforward, for example if a TC+ happened right next to a main break and a leaky septic field. In that case, the sanitary defect (septic contamination) could likely be identified as the cause of the TC+.

Sometimes, a program or procedure that could potentially be a sanitary defect is found—for example: not having a coliform sample collection SOP. In that case, the sampler might have collected the samples correctly—in which case it could be said that the sanitary defect (lack of SOP) was NOT the cause of the TC+, but it could

Additional Issue Description and Comments–(Optional)

If the Level 1 Assessment finds sanitary defects that are not specifically related to compliance with the TCEQ's rules and regulations, the PWS has the option to note those on the Level 1 Assessment form.

The best way to document these is to follow the same format as the sanitary defects. Basically, describe the issue, the corrective action, and the timeline. The only difference is that these additional issues are not violations. However, they have the potential of becoming either sanitary defects and/or violations in future.

Corrective actions in the CARP

The CARP is where everything comes together. The CARP should explain any findings that are listed in the answers to the questions in Sections 1-7 of the Level 1 Assessment form.

Each item listed on the CARP should be described in the CARP. If there is not enough room in the box on the Level 1 Assessment form, additional pages should be attached.

Was any corrective action taken?

Whether or not it led to a TC+, a sanitary defect should be corrected. Often, this is a simple matter. For example, if there was no sample collection SOP, so an operator collected a sample in the rain, it is straightforward to get the recommended SOP from TCEQ guidance and modify it to fit the specific PWS. Or, if a failed backflow prevention device caused contamination, that device can generally be replaced in the 30 day time frame.

Does the PWS have plans to take corrective action?

Often, an assessment will just report on some issue that is already fixed. For example, if a pipe break caused contamination, but was immediately fixed.

Other times, fixing a sanitary defect will take longer. In that case, the first step that the Assessor should take is to consult with the TCEQ about requesting additional time. While the TCEQ understands that additional time is needed, the rules require the PWS to provide the details of the extension request. If construction is needed, the submittal will need to include a FAST.

If it is determined that more time is needed to correct a sanitary defect, the Assessor should immediately consult with the TCEQ.

Writing up a CARP item

Issue description

The issue description should reference the corresponding section letter and question number. For example, if a treatment interruption occurred, the question listed would be .

Multiple questions could possibly be described in one item, for example, if low pressure was a problem, the questions listed could include J.2, 3, and 4.

Corrective action(s)

Any actions the PWS took to correct the listed issue should be described. For example, if the problem was *"Someone left a flush valve open and depressurized the area,"* then the corrective action might be *"Closed the flush valve and re-trained operators."*

If a corrective action was not completed, it should still be described. For example, if the problem was *"Tornado demolished elevated storage tank and depressurized area,"* the corrective action might be *"Need to remove debris and get new tank built. Boil water notice in place till pressure can be maintained."* In this case, the Assessor

would consult with the TCEQ to seek approval for more than 30 days to fix the problem and submit a FAST describing the timeline for getting the money and installing the new tank.

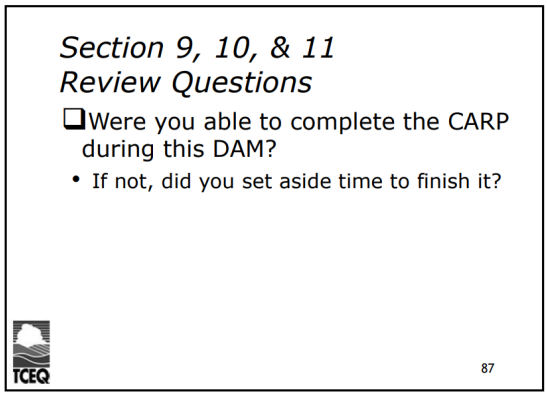
Status of corrective action

The Assessor should report whether the status of a given corrective action is complete or if more time is needed. If more time is needed, a FAST (Financial Assurance Statement and Timeline) should be attached and this should be noted on the Level 1 Assessment Form.

In order to request additional time to correct a problem, the PWS must document that the correction shall take place. In order to document this, the PWS must submit documentation that funds are available to complete the work, and describe how long it will take to get it done, specifically:

- The general scope of the project. For example, *"Fix tank hatch destroyed by the class of 2018."*
- The expected cost. A ballpark estimate is adequate, but part of the follow up requirement will be a more detailed estimate.
- How the project will be paid for. If funds are available, state that. If funds are not immediately available, describe how they will be sought.
- A timeline for engineering, approval, bidding, construction, training, and any other needed actions.

After you review the questions about Sections 9, 10, and 11 on slide 87, you can wrap up the training by completing the Post-test and Course Evaluation Form.



Thanks for your participation!

Appendix 1: Coliform sites and sample collection

This appendix provides supplemental information related coliform sites and sample collection. It applies to Section 1 and 2 of the Level 1 Assessment form.

This information is provided as guidance and assistance. It describes best practice recognized by the drinking water industry.

Characteristic sample collection

Effective execution of the nitrification action plan (NAP) requires that we understand the water quality in the distribution system mains and storage facilities. That is where we find the nitrification factors about which we can take action.

Consider what water the sample represents

Think about where the water you collect in your bottle or cell comes from. Is it stagnant water from the sample line? Is it bulk water from the closest main? Or is it from far away?

Water may sit in fire hydrants and service lines for a long time, but that water does not characterize or represent the water that is in the main lines, and it is not the water that we should be sampling.

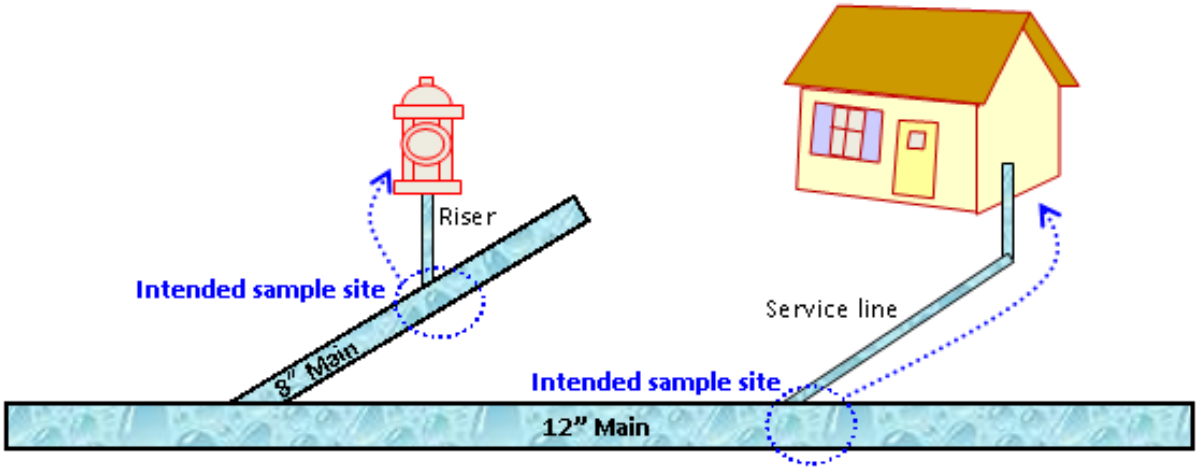


Figure showing the intended sample site that characterizes bulk water in the main

Ideally, water should be flowing through your mains constantly to reach distant areas and to meet customer demands. That continually flowing water is normally of better quality than the water sitting in customer's service line. In any case, if we don't know how much a water a connection is using when we sample, we can't know the age of the water in the service line.

Accurate data leads to sound decisions

Accurate data is needed to characterize distribution system water quality based on location and estimated water age. This is an essential component of the NAP. Good, accurate data supports good decision making.

Tips to collect accurate data include:

- Use a *consistent* and *technically sound* approach for sample collection.
- Samples should characterize water in the distribution main *immediately adjacent to the sample location*
- Flush or waste potentially stagnant water in the line leading to the sample tap before collecting a sample (two times the calculated flush time or CFT)
- *Avoid over-flushing*, which may pull in water from another area of the distribution system

Flushing versus sampling

Flushing a line to clear out older water for quality control purposes is different from flushing a line to collect a representative sample. When we are performing routine flushing, we want to scour sediment and debris from the line. However, when we are collecting a sample, we want to find out the condition of the water and picking up debris does not help us collect good samples.

Often, PWSs use a rule-of-thumb, like "flush for five minutes." Five minutes may or may not be a good amount of time depending on the length and diameter of the pipes.

In 2003, a study by the Water Research Foundation determined the best way to sample water in the main line and not in a service line. They found that a volumetric approach should be used, based on:

- The service line length,
- The service line diameter, and
- A known, pre-determined flow rate.

Calculated flush time and safety factor of two

The calculated flush time is the time it takes for water to travel from the intended sample location to the sample tap.

We use a safety factor of two (2) and flush for two times the calculated CFT in order to fully clear the line of standing water, but not bring in water from too far away.

Fire hydrants as sample locations:

Fire hydrants—1,000 gpm

Usually, fire hydrants can be problematic for sampling because:

- The flow is not a 'pencil-thin' stream (which is needed for coliform sampling);
- It can waste a lot of water, which is undesirable especially during drought;
- Because the flow is so high, water is likely not characteristic of the immediately surrounding pipes;
- In locations with lots of sediment, particles may get into sample water which can cause inaccuracy; and

- Operators may turn the hydrant on and off too quickly, causing destructive water hammer.

Hydrant sampler—20 gpm

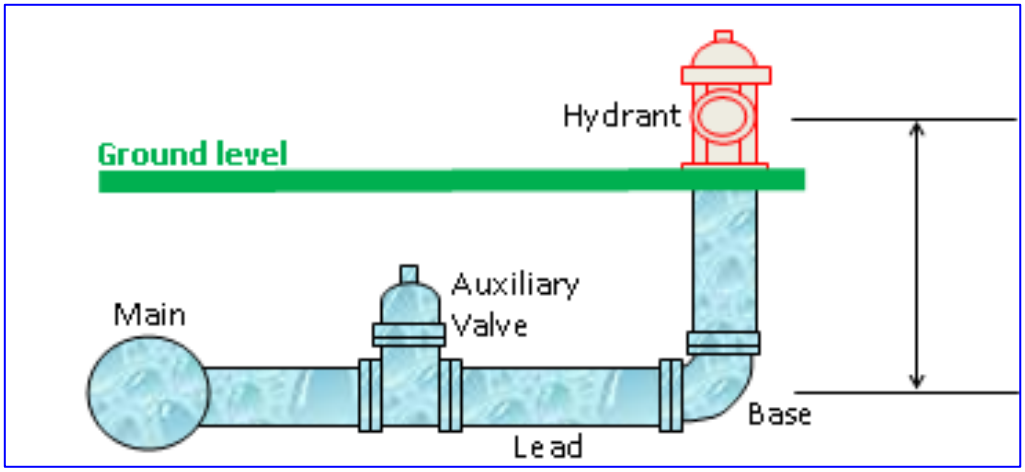
Using a hydrant sampler with flow control—like the one shown—can solve some of the issues with sampling hydrants.

Fire hydrants have good qualities for collecting distribution system samples because they conform to generally consistent construction and operational parameters. By using a hydrant sampler

- the flow rate from the hydrant is limited to 20 gpm,
- the water velocity is too low to pick up sediment,
- a pencil-thin stream is available for sampling,
- water is not wasted, and
- an accurate sample can be collected.

Typical hydrants

This figure shows some typical construction guidelines for fire hydrants. From these, or from site specific construction information we can estimate the volume of the pipe.



Tips for estimating hydrant size for determining calculated flush time:

(These assumptions may differ from actual sizes—verify if possible.)

Typical leads:

- Diameter: AWWA Manual M17 suggests a 6" diameter lead. Assume a hydrant lead diameter of 6"
- Length: Assume the pipe length to be the horizontal distance from the auxiliary valve to the hydrant plus 1' to be conservative.

Typical hydrant diameter:

The majority of hydrants are 5 1/4" or 4 1/2" (main valve opening). Assume a 6" diameter hydrant.

Typical vertical distance:

AWWA standards suggest a minimum of 60" from the hydrant nozzle to hydrant lead pipe. Assume 6' length to be conservative.

Site specific calculations

When we do know the pipe diameter and length serving the hydrant, we can calculate the flush time much more accurately.

Customer taps as sample: locations

A customer tap is another alternative sample location. These taps are less reliable than fire hydrants, because there are often many unknowns about the length and diameter of the lines leading to the taps.

he flushing time is assumed to be two gallons per minute. This can be assured by a flow control device or by capturing water in a five-gallon bucket to confirm and/or adjust the flow rate.

Often, the line diameter will be based on the operator's best judgement, but sometimes the customer can provide the information. Measure the distance from the meter to building and estimate the pipe length to the outside tap you are using.

When we can do this we can normally accept a safety factor of two by flushing two of the calculated volumes from the line.

If the total line length is 10 feet and the diameter is 6 inches, then the volume of the pipe is 14.7 gallons. If we flush at 20 gpm, we only need to flush for 0.7 minutes. However, we also want to have a safety factor. Because we are making assumptions about the length of the pipe from the main to the valve, we will add a larger than normal safety factor and just establish a flush time of 3 minutes for rarely used flush valves with unknown pipe length and pipe diameter.

The Calculated Flush Time (CFT) Matrix is provided below. This matrix was created by the EPA Technical Support Center (TSC) in Cincinnati, Ohio. The times shown in the matrix (in minutes) assume that:

- The sampler wishes to flush two volumes from the line to ensure that a sample representative of the water in the main is collected.
- The sampler has a means to flush at 20 gallons per minute (gpm), a flushing rate chosen to:
  - Prevent scouring debris from the main line, and
  - Minimize the necessary flush time to as low a number as practical.
  - The flow rate can be assured by a flow control device or by capturing water in a five-gallon bucket to confirm and/or adjust the flow rate.

Flush Time in Minutes at 20 gpm
(Time shown in minutes for flushing two (2) pipe volumes)

Length of Pipe (ft)	Inside Diameter (Nominal) of the Fire Hydrant or Pipe (inches)					
	2	4	6	8	12	16*
1	0.0	0.1	0.1	0.3	0.6	1.0
5	0.1	0.3	0.7	1.3	2.9	5.2
10	0.2	0.7	1.5	2.6	5.9	10.4
15	0.2	1.0	2.2	3.9	8.8	15.7
20	0.3	1.3	2.9	5.2	11.8	20.9
25	0.4	1.6	3.7	6.5	14.7	26.1
30	0.5	2.0	4.4	7.8	17.6	31.3
35	0.6	2.3	5.1	9.1	20.6	36.6
40	0.7	2.6	5.9	10.4	23.5	41.8
45	0.7	2.9	6.6	11.8	26.4	47.0
50	0.8	3.3	7.3	13.1	29.4	52.2
55	0.9	3.6	8.1	14.4	32.3	57.4
60	1.0	3.9	8.8	15.7	35.3	62.7
65	1.1	4.2	9.5	17.0	38.2	67.9
70	1.1	4.6	10.3	18.3	41.1	73.1
75	1.2	4.9	11.0	19.6	44.1	78.3
80	1.3	5.2	11.8	20.9	47.0	83.6
85	1.4	5.5	12.5	22.2	49.9	88.8
90	1.5	5.9	13.2	23.5	52.9	94.0
95	1.6	6.2	14.0	24.8	55.8	99.2
100	1.6	6.5	14.7	26.1	58.8	104.4

** This would normally flow at over 20 gpm*

The Calculated Flush Time Matrix for premises (also developed by the TSC) is shown below. Notice that the same safety factor is used as with the fire hydrants, a factor of two.

Flush Time in Minutes at 2 gpm
(Time shown in minutes for flushing two (2) pipe volumes)

Length of Pipe (ft)	Inside (Nominal) Diameter of the Pipe (inches)									
	3/4	1/2	5/8	3/4	1	1 1/2	2	2 1/2	3	4
1	0.02	0.01	0.02	0.02	0.04	0.09	0.2	0.3	0.4	0.7
5	0.11	0.05	0.08	0.1	0.2	0.5	0.8	1.3	1.8	3.3
10	0.23	0.10	0.16	0.2	0.4	0.9	1.6	2.5	3.7	6.5
15	0.34	0.15	0.24	0.3	0.6	1.4	2.4	3.8	5.5	9.8
20	0.5	0.2	0.3	0.5	0.8	1.8	3.3	5.1	7.3	13.1
25	0.6	0.3	0.4	0.6	1.0	2.3	4.1	6.4	9.2	16.3
30	0.7	0.3	0.5	0.7	1.2	2.8	4.9	7.6	11.0	19.6
35	0.8	0.4	0.6	0.8	1.4	3.2	5.7	8.9	12.9	22.8
40	0.9	0.4	0.6	0.9	1.6	3.7	6.5	10.2	14.7	26.1
45	1.0	0.5	0.7	1.0	1.8	4.1	7.3	11.5	16.5	29.4
50	1.1	0.5	0.8	1.1	2.0	4.6	8.2	12.7	18.4	32.6
55	1.3	0.6	0.9	1.3	2.2	5.0	9.0	14.0	20.2	35.9
60	1.4	0.6	1.0	1.4	2.4	5.5	9.8	15.3	22.0	39.2
65	1.5	0.7	1.0	1.5	2.7	6.0	10.6	16.6	23.9	42.4
70	1.6	0.7	1.1	1.6	2.9	6.4	11.4	17.8	25.7	45.7
75	1.7	0.8	1.2	1.7	3.1	6.9	12.2	19.1	27.5	49.0
80	1.8	0.8	1.3	1.8	3.3	7.3	13.1	20.4	29.4	52.2
85	2.0	0.9	1.4	2.0	3.5	7.8	13.9	21.7	31.2	55.5
90	2.1	0.9	1.4	2.1	3.7	8.3	14.7	22.9	33.0	58.8
95	2.2	1.0	1.5	2.2	3.9	8.7	15.5	24.2	34.9	62.0
100	2.3	1.0	1.6	2.3	4.1	9.2	16.3	25.5	36.7	65.3

Hydrant sampler and tap sampler

This Appendix shows how to make a hydrant sampler or tap sampler to help with sampling. It is provided here to help PWS staff provide some tools that can be used to make sure that coliform samples are collected from the distribution main—not from stagnant water in the sample line.

The US EPA Technical Support Center (TSC) has developed some tools to help systems perform more consistent sampling for distribution system studies. These devices control the flow but they also have other features that can be useful.

The hydrant sampler has

- a pressure gauge,
- a temperature probe,
- a flush line to which one can attach a hose to direct the water flow, and
- a side-stream valve that can be used to collect a sample at a lower rate.

The tap sampler is fitted with

- a hose to direct the flush-water in the direction you choose and
- a temperature probe.

The other features fitted to the hydrant sampler would not be useful when collecting a sample from the customer's tap.

All these procedures are designed to ensure that you can collect a representative sample and obtain accurate information about your distribution system

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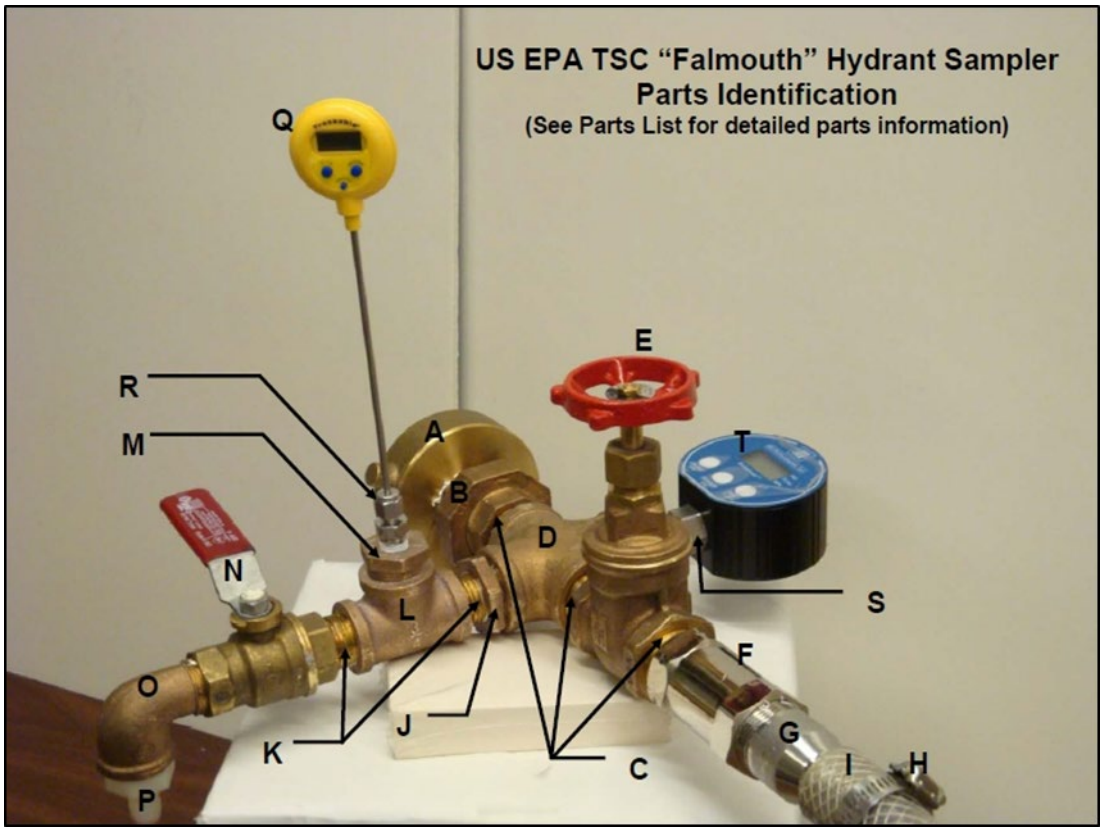
The EPA's Technical Support Center (TSC) helps PWSs and states (like Texas) with strategies for successful operation. This procedure and description are adapted from EPA TSC documents.

Hydrant sampling device

In distribution system sampling, oftentimes residential or business taps are not available to sample at (especially in remote areas of the system), so hydrants are used. Since hydrants are designed to be fully open, a device is needed to keep the hydrant open, but allow the sampler to sample the water in controlled, safe manner. See details provided below.



Picture of EPA TSC "Falmouth" Hydrant Sampler

Procedure for Using Hydrant Sampler

This is a generic procedure you can follow. For your system, you may want to update this to add any steps or processes unique to your system.

1. Make sure you have a data sheet to record your results.
2. Make sure you have the list of sites with their calculated flush time (CFT).
3. Close all valves on sampler and connect to hydrant.
4. Open hydrant (**slowly**) until fully open.
5. Open main valve on sampler, start the timer. The flowrate is set to 20 gpm by the orifice on the flow control valve.
6. At the CFT or time designated by the rule of thumb close the main valve, open the side-stream sample valve, and collect the water sample(s). If multiple samples are collected over a significant span of time relative to the flushing time, turn off the tap in between samples.
7. Take water temperature reading at time of sample. If CFT is unknown track temperature stabilization along with CFT to estimate adequate flush.
8. Take water pressure reading at time of sample (if desired).
9. When sampling is completed shut off all valves and slowly close hydrant.
10. Make sure you wrote: Location, Date, Time start/time end, Temperature, and all analytical results on your data sheet.

Hydrant Sampler Parts Lists

Main Section of Sampler

Item	Photo Letter	# Per Sampler
Hydrant Adapter/Reducer (2½" FNST Inlet by 1" MNPT Outlet)B	A	1
1" FNPT Brass, Water Pressure Reducing Valve		1
1" FNPT Brass Union	B	1
1" MNPT Red Brass Nipple, Closed Threaded	C	3
1" FNPT Red Brass Cross	D	1
1" FNPT Brass Gate Valve	E	1
Dole Flow Control Valve, 20.0 GPM, 1" FNPT Inlet/Outlet	F	1
1" MNPT X 1" ID Red Brass Hose Adapter	G	1
#16 Hose Clamp for 1" ID Hose	H	1
Thread Sealant Tape, PTFE, 3/4" × 520"	-	1
1" ID Hose (Reinforced PVC), 50 ft	I	5 ft

Sampling Section

Item	Photo Letter	# Per Sampler
1" MNPT X 3/4" FNPT Red Brass Reducing Bushing	J	1
3/4 " MNPT Red Brass Nipple, Closed Threaded, pk/5	K	2
3/4" FNPT Brass Tee	L	1
3/4"MNPT X 1/4" FNPT Red Brass Reducing Bushing	M	1
3/4" FNPT Brass Ball Valve	N	1
3/4" NPT 90° Red Brass Street Elbow	O	1
3/4" MNPT X 1/4 " ID Nylon Hose Adapter	P	1

Temperature Probe

Item	Photo Letter	# Per Sampler
Temperature probe with X" probe diameter (Must have accurate measurement of probe diameter)	Q	1
X" X 1/4" NPT Male Connector, Bored Through with Teflon Ferrule C	-	1
PTFE Front Ferrule, 3 mm	-	1
PTFE Back Ferrule, 3 mm	R	1

Pressure Gauge

Item	Photo Letter	# Per Sampler
1" MNPT x 1/4" FNPT Chrome Plated-Brass Reducing Bushing	S	1
SSI 300 PSI Digital Pressure Gauge, 1/4"MNPT Connector	T	1

Footnotes for the parts tables

A--Fittings are rated for maximum of 150 psi, sampler may not be safe when system pressures exceed this value. Sampler could be modified to include a pressure reducing valve (PRV).

B--Some systems have special hydrant threads specific to their system, however the majority of systems use FNST.

C--Size of male connector (X) depends on probe diameter of temperature probe used

Possible Sources for Parts

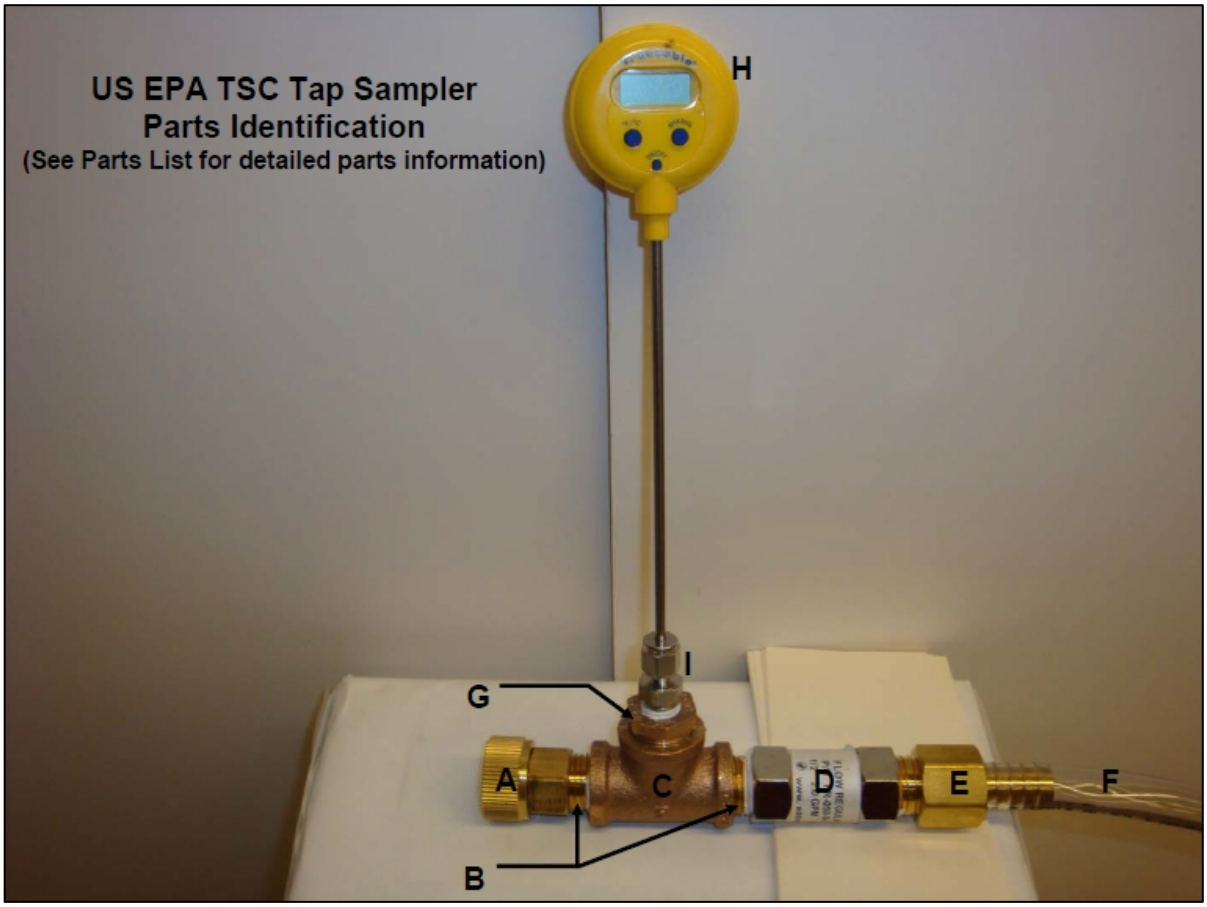
- Pollard Water - www.Pollardwater.com, or 800/437-1146
- Grainger - www.grainger.com, stores nationwide
- Home Depot
- Swaqelock - Check at swagelock.com for local supplier
- Eddington Industries, LLC - www.eddington-ind.com
- Fisher Scientific - www.fishersci.com

Hose-bibb tap sampler

After the hydrant sampler was designed and constructed, a tap sampler was later designed for sampling at residential and business hose bibbs or other taps that would allow the sampling team to measure an accurate calculated flush time at the desired 2 gpm flowrate.

Procedure for Using the Tap Sampler

1. Make sure you have a data sheet to record your results.
2. Make sure you have the list of sites with their calculated flush time (CFT).
3. Remove aerator and connect sampler to faucet.
4. Turn on cold water tap fully and start the timer. The flowrate should be set to 2 gpm based on the flow control valve
5. At 2xCFT or time designated by the rule of thumb turn off the tap and collect the water sample(s). If multiple samples are collected over a significant span of time relative to the flushing time, turn off the tap in between samples.
6. Take water temperature reading at time of sample. If CFT is unknown track and record temperature stabilization along with CFT to estimate adequate flush.
7. When sampling is completed disconnect from faucet.



Picture of EPA TSC Tap Sampler

Parts List for Main Section of Tap Sampler

Item	Photo Letter	Quantity Per Sampler	Potential Source
Garden hose coupling, 1/2" FNPT outlet	A	1	1,5
1/2" NPT close nipple	B	2	1,5
1/2" NPT Tee	C	1	1,5
Dole Flow Control Valve - 2.0 gpm, model 2GB, 1/2" FNPT inlet/outlet	D	1	1,5
1/2" MNPT X 1/2" ID hose adapter	E	1	1,5
1/2 " ID hose	F	2 ft	2

Parts List for Temperature Probe Section of Tap Sampler

Item	Photo Letter	Quantity Per Sampler	Potential Source
Reducing bushing 1/2" NPT X 1/4" NPT	G	1	1,5
Temperature probe with X" probe diameter (must have accurate measurement of the probe diameter)	H	1	6
X" X 1/4" NPT male connector, bored through with Teflon ferrule (Size of the male connector (X") depends on the probe diameter of the temperature probe used.)			3

Potential sources

1--Pipe fittings are available at plumbing supply and hardware stores

2--Hose, fittings and hardware available at Lowes and Home Depot

3--Swagelock - Check at swagelock.com for local supplier

4--Eddington Industries, LLC (888) 813-9900

5--Grainger - www.grainger.com, stores nationwide

6--Scientific equipment suppliers

Coliform SOP

The required elements of a coliform sample collection SOP are described below, and an example is shown after that. Appendixes 3 and 4 expand on how to collect samples that accurately characterize the water in the mains.

It is important that samples are collected correctly; otherwise, they may be contaminated, and the results used to determine the condition of the PWS can be inaccurate.

SOP Elements

An SOP for collecting routine and repeat coliform sample should include these elements:

- Don’t collect samples during or right before heavy flushing has been performed in the area you are taking the sample
    - Heavy flushing can stir up sediment that is not representative of distribution water.
- Don't collect samples when weather could contaminate the sample.
    - State what to do on windy or rainy days. For example, delay sample collection to the following day. Or, specify an alternate site for those conditions.
- Sample according to the schedule and sites in the Monitoring Plan
- Remove any appurtenances from the sampling tap before collecting the sample
- Have clean hands.
    - Wash hands or use sterile gloves when taking the samples.
- Disinfect the sampling tap.
    - Swabbing or spraying with a chlorine solution prior to collecting the sample.
    - If materials are all metal, flaming may be used.
- Flush the water from the sampling line before collecting the sample.
    - Make sure that enough water is flushed to make sure the water is representative of distribution system lines/pipes and is not stagnant water in the sample line or premise plumbing.
    - Ensure that the flushing is short enough that it represents local water, not water from a long distance away from the sampling tap.
    - If you base the flush time on a change in temperature, do training to make sure all sample collectors are capable of detecting small changes in water temperature, and document flush times.
- Use sterile, appropriate bottles, provided by your accredited lab, to collect sample water.
    - Check the expiration date to make sure that the bottles are not old.
- Collect disinfectant residual
    - Use the correct measurement for ‘free’ or ‘total’ chlorine.
    - Use approved methods.
    - Use appropriately calibrated instruments.
    - Write the residual on the form.

- Collect the sample.
    - Do not touch the bottle or cap, blow into the inside of the bottle or cap, place the cap on the ground or hold the bottle upside down.
    - Use a smooth, pencil-sized stream of water. Direct the stream downward to the inside of the bottle to avoid splashing.
    - Do not over- or under-fill the bottle. Fill the sample bottle to the shoulder only—100 mL line.
- Check the correct box for "Routine," "Repeat," "Construction," or "Special."
- Fill out bacteriological sample submission form correctly. Route the sample correctly.
- Don’t transport the samples in the same cooler as wastewater samples.
    - Keep the samples out of direct contact with the ice and water by using a rack or putting bottles in a sealed plastic bag.
    - Keep the samples cool but not frozen.

Coliform Sample Collection SOP Example

When and where to collect routine samples

- Follow the schedule in the Monitoring Plan
    - Don’t collect samples during or right before heavy flushing
    - Don't collect samples when weather could contaminate the sample.
- If rain is expected the day of sampling (or the day after)—Reschedule.

How to collect routine samples

- Remove any appurtenances from the sampling tap before collecting the sample
- Have clean hands. Wash hands, wear sterile gloves when taking the samples.
- Disinfect the sampling tap.
    - Swab or spray with a strong chlorine solution before collecting the sample.
    - For metal taps, flame with torch.
- Flush the sample tap before sampling.
    - Flush for the appropriate time (for example, 10 minutes)
    - The flushing time should be short enough that it represents local water, not water from a long distance away from the sampling tap.
    - If you base the flush time on a change in temperature, measure it
- Use sterile, unexpired bottles, provided by the lab
    - Check the expiration date to make sure that the bottles are not old.
- Collect and record disinfectant residual
    - Use approved methods.
    - Use appropriately calibrated instruments.
    - Use the correct measurement for ‘free’ or ‘total’ chlorine.
    - Do a dilution if the level is out-of-range (too high).
    - Write the residual on the form.
- Collect the sample.
    - Do not touch the bottle or cap, blow into the inside of the bottle or cap, place the cap on the ground or hold the bottle upside down.
- Use a smooth, pencil-sized stream of water. Direct the stream downward to the inside of the bottle to avoid splashing.
- Do not over- or under-fill the bottle. Fill the sample bottle to the shoulder only—100 mL line.

Chain-of-custody

- Fill out bacteriological sample submission form correctly.
    - Check the correct box for "Routine," "Repeat," "Construction," or "Special."
- Route the sample correctly.
    - Don’t transport the samples in the same cooler as wastewater samples.
- Keep the samples out of direct contact with the ice and water by using a rack or putting bottles in a sealed plastic bag.
    - Keep the samples cool but not frozen.

Additional sampling

Looking at the progression of TC+ in the system can help the assessor track where the origin of the bacteria may be. Additional samples include:

- Repeats, and
- Special sampling.

Repeats

Under the RTCR, the required distribution repeats are always collected at the same three sites:

1. The original routine site,
2. the designated 'upstream' site, and
3. the designated 'downstream' site.

Repeat sites must be documented in the Monitoring Plan—specifically in the coliform sample siting plan. The web site for the coliform sample siting plan is:

https://www.tceq.texas.gov/drinkingwater/microbial/revised-total-coliform-rule

The RTCR does not 'track' coliform presence through the pipes like the TCR did. Under TCR, repeats were taken progressively farther away from the original TC+, forming a 'tree' of sample locations.

Ground Water Rule (GWR) samples

The Ground Water Rule (GWR) requires that every operational groundwater source feeding a distribution system be sampled for *E. coli* after any TC+ is found in distribution.

Note that in some cases, you must collect five (5) sequential samples from each source. Call TCEQ at 512-239-4691 to check on this before collecting your raw repeats.

You can either collect the five samples at intervals—for example every 15 minutes—or you can collect a single sample and pour it into 5 sample bottles while in the field. You may not collect a single sample and bring it back to the lab to split up because the samples must be field-preserved.

Note that the GWR includes requirements for wholesaler groundwater sources. Therefore, raw samples from any wells at wholesalers must also be collected within 24 hours of the wholesale connection collecting a TC+. Those results must be considered in this question.

Purchasers should document that you notified the wholesaler of the need for samples in a timely manner. Keep copies of the wholesaler's response.

Wholesalers should document that you provided the results of raw water coliform sampling in response to a TC+ in a downstream system within 24 hours.

Correction options for failure to collect repeats

It is impossible to go back in time and collect samples, so the best correction option is to establish a protocol that lessens the potential for failing to collect the required

repeats or triggered source raw water samples in future. The Monitoring Plan should be updated to include changes to the protocol.

Special sampling

The RTCR does not 'track' coliform presence through the pipes like the TCR did. Under TCR, repeats were taken progressively farther away from the original TC+, forming a 'tree' of sample locations.

However, additional coliform sampling may be useful for your investigation of the incident. If you take samples at different locations for investigation purposes, mark the bacteriological sample submission form "Special."

Notes

Appendix 2: Special precautions in response to loss of pressure

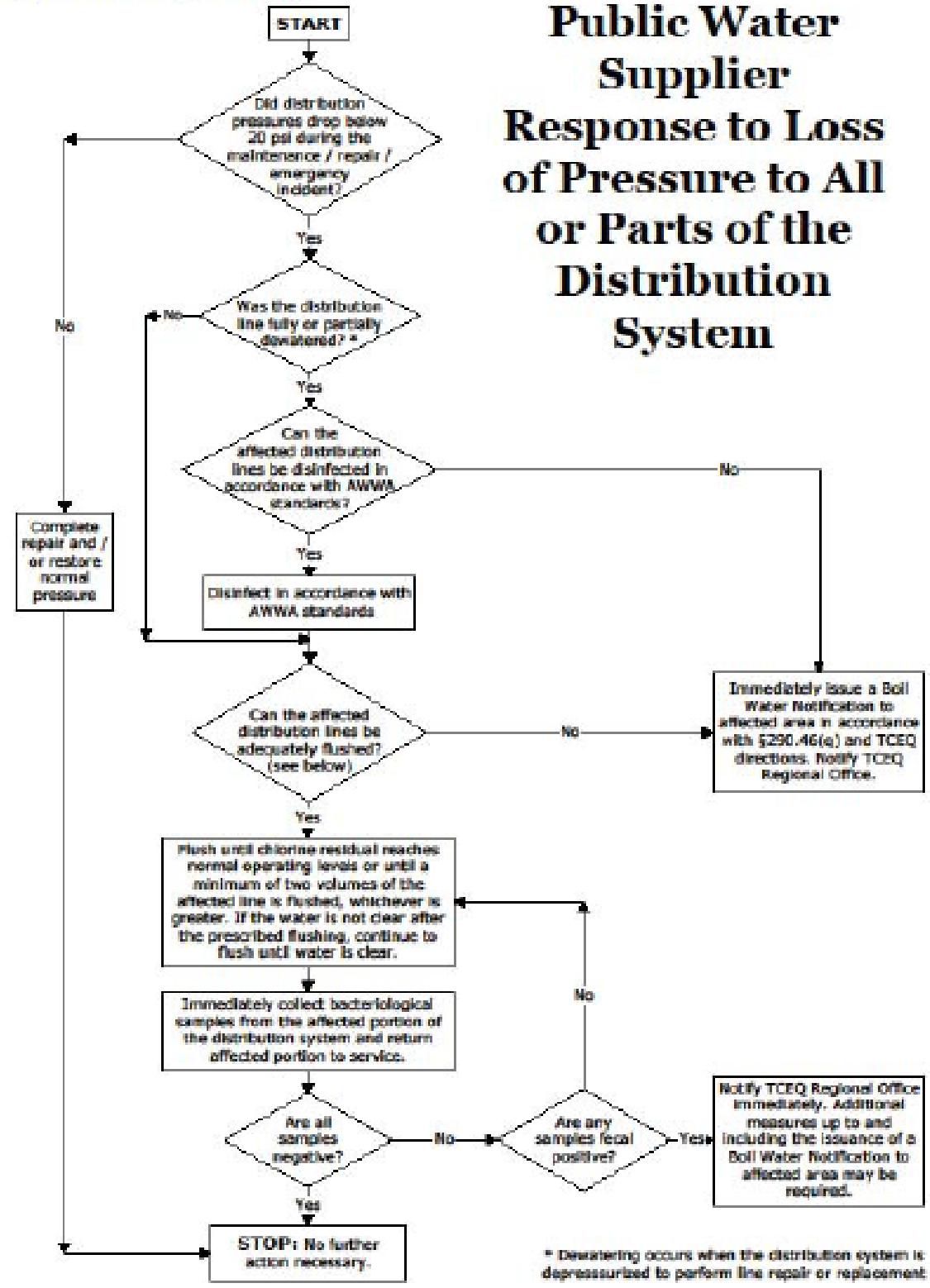
This appendix provides the flowchart on special precautions that PWSs are required to take when pressure in the distribution system drops below 35 psi, or 20 psi.

Whenever there is a loss of pressure it is a best practice to respond, and, if there is a risk, to correct it and let people know what appropriate action to take—for example, to boil water.

Depending on the nature of the event, a PWS may choose to disinfect and flush an area out of concern, even if the pressure is over 20 psi.

The TCEQ has specific requirements in §290.46(q) and §290.47(e). The flow chart showing the procedures to follow when pressure drops below 20 psi is shown below.

Figure: 30 TAC §290.47(e)



Special Precautions Flow Chart

Appendix 3. Disinfectant residual

Every PWS is required to maintain a disinfectant residual throughout the distribution system at all times. Disinfectant residuals protect against pathogens that may enter the distribution system through leaks, cross-connections, backflow/backpressure events. Disinfectant residuals also protect against pathogens that may be harbored or spawned in biofilms found in pipe tuberculation.

Scope

This appendix is intended to provide additional assistance to an assessor determining the disinfection adequacy at a PWS.

Documents and data

PWSs in Texas are required to monitor disinfectant residual using approved, calibrated analytical equipment. The assessor should have access to this data.

Resources

Disinfectant sampling requirements are described in the TCEQ regulations in §290.110. The TCEQ also has guidance for disinfectant sampling in Regulatory Guidance 407 (RG 407).

Required disinfectant samples—assessment process

Look at the daily sheets, route sheets, and Monitoring Plan. See if they match.

Small systems, serving 250 connections or fewer AND serving 750 people or fewer, must collect disinfectant residuals at sites representative of the entire distribution system weekly.

Larger systems must collect disinfectant residuals daily at sites representative of the entire distribution system daily, including Saturday and Sunday.

Wholesale PWSs are sometimes unclear on whether distribution requirements apply to their system. The requirements apply because the wholesaler's transmission mains are included in the TCEQ definition of distribution pipes.

The requirement that sites represent the entire distribution system means that it is not acceptable to collect a single sample to represent the entire system if **more than one pressure planes** are present, or if the system has other complexity.

Correction options

A PWS should correct a monitoring issue immediately by beginning to take disinfectant samples at the proper intervals, and at locations that are representative of the entire distribution system. Additionally, they should ensure that the samples are properly rotated through samples sites, in order to make sure every customer's water is represented. Changing the sampling sites and times will require revisions to the Monitoring Plan.

Be aware that failure to collect all required samples is a monitoring violation; failure to send reports is a reporting violation. These may require public notification. An assessor should consult with the TCEQ if this situation occurs.

It is always recommended that regulated entities retain documentation regarding communication with TCEQ, for example: e-mails and letters.

Reporting results on the DLQOR or SWMOR

Systems that only use purchased-water and groundwater sources must report their distribution disinfectant residual data on the Disinfectant Level Quarterly Operating Report (**DLQOR**). C and NTNC systems send those to TCEQ quarterly. TNC systems are required to keep them on site for review by the TCEQ.

Systems that operate SWTPs (or GUI treatment) must submit distribution disinfectant residual information on page 1 of the **SWMOR**. If entry point data is reported on page 1 of the SWMOR, that is incorrect: the data from distribution must be reported. During the Level Assessment the assessor can double check to see if the daily records match the DLQORs.

Correction options

Generally, if reports have been completed incorrectly in the past, the solution is to make sure they are done right in future. If the problem was that mail was going astray, a PWS can consider using certified mail, so they have proof that it was mailed on time, and received or not.

DLQOR

The DLQOR form is available on the web for electronic submittal. If a PWS has the computer resources to use this, they will get confirmation that it has been received. The form is on the web at:

www.tceq.state.tx.us/assets/public/permitting/watersupply/pdw/dlqor/dlqorform_032911.pdf

SWMOR

There are several DAMs available for training operators on how to complete SWMORs. For example, training is available for convention SWTPs and also for membrane plants and alternate disinfectants like ozone and ultraviolet disinfection.

Additional information on SWMORs is available on the TCEQ's web site at:

www.tceq.texas.gov/drinkingwater/swmor/swmor/swmor-forms-and-instructions

If a Level 1 Assessment is being performed at a SWTP, and the assessor does not have expertise with surface water treatment, it is recommended that they seek expert assistance.

Required minimum residuals

Minimum required residual disinfectant levels protect against bacteria and other pathogens in the distribution system.

- If **free chlorine** is used in distribution, the residual should never fall below **0.2 mg/L**.
- If **monochloramine (chloramines, total chlorine)** is the disinfectant, the residual should never fall below **0.5 mg/L**.

This information is reported on the DLQOR or SWMOR, but the raw data is usually in the operator's log book or on daily data sheets.

The assessor should review recent distribution residuals.

Looking at disinfectant residual is a very useful tool for finding and solving problems. Particularly focus on record for the area and time immediately surrounding the TC+ samples. Consider how the water flows in that area. Look at the map, and see if there is a pattern; for example, if one street has low residual but a nearby area doesn't. Map the data, even roughly. Consider where valves are. Different issues will impact the residual in different ways. A cross connection may influence a one-block area, whereas nitrification may impact vast areas.

Correction options:

Ultimately, the correction option is to implement necessary treatment and operational adjustments to ensure that the disinfection residual in the distribution system remains greater than or equal to the regulatory minimums. This may be complex, depending on the cause.

Be aware that two consecutive months in which 5% or more residual samples are below the minimum is a treatment technique violation which may require public notification. An Assessor should consult with the TCEQ if this situation occurs. The TCEQ can provide free, on-site assistance through its FMT program. For more information call the TCEQ's Water Supply Division at 512-239-4691.

Reliable analyzers

All instruments that are used to measure chemicals must be calibrated or verified every 90 days [290.46].

An assessor should consider whether the data that the PWS is collecting is reliable. If analyzers are not maintained, that data is suspect. Bad data leads to bad decisions.

Records of calibration and verification must be retained by the PWS.

Mapping and Graphing

Mapping

Mapping the disinfectant residual on the distribution map is a powerful—yet simple—way to understand and control your distribution system. Trends and deviations from 'normal' levels can alert operators to possible problems.

The process is simple—just get a distribution map and write the historical chlorine levels on it. Depending on the amount of data you have, you will need to make some decisions about how much of it to graph.

Minimum, maximum, or average?

If there is a lot of data, it can make the map look messy. Using the average is a common way to simplify the data, and the map. However, averages should be taken with a grain of salt, especially if there is a great deal of variation in residuals at a site.

One way to add information is to plot all of the minimum, maximum, and average. (As shown in the example below).

Another way to evaluate the variation for a site is to use a spreadsheet program to calculate the standard deviation. The higher the standard deviation, the more variability there is.

If most sites have very low variability, and one site has lots of variability, it may be worth looking at the variable site more closely. Variability might mean that usage is extremely variable in that area, and more flushing is needed during periods when usage is low.

Period of data?

Generally, the more data you have, the more you can learn. However, using a small portion of the data may lead to more insight. For example, if you are having problems in summer, but not winter, it may be useful to separate the data. Comparing a 'summer map' to a 'winter map' may reveal a pattern that was not seen from just looking at data tables.

Sometown, Texas—Mapping & Graphing example

Here is the example site table for Sometown, Texas, whose distribution map shown on the next page:

Example of Monitoring Plan Disinfectant Residual
Sample Site Table for Sometown, Texas

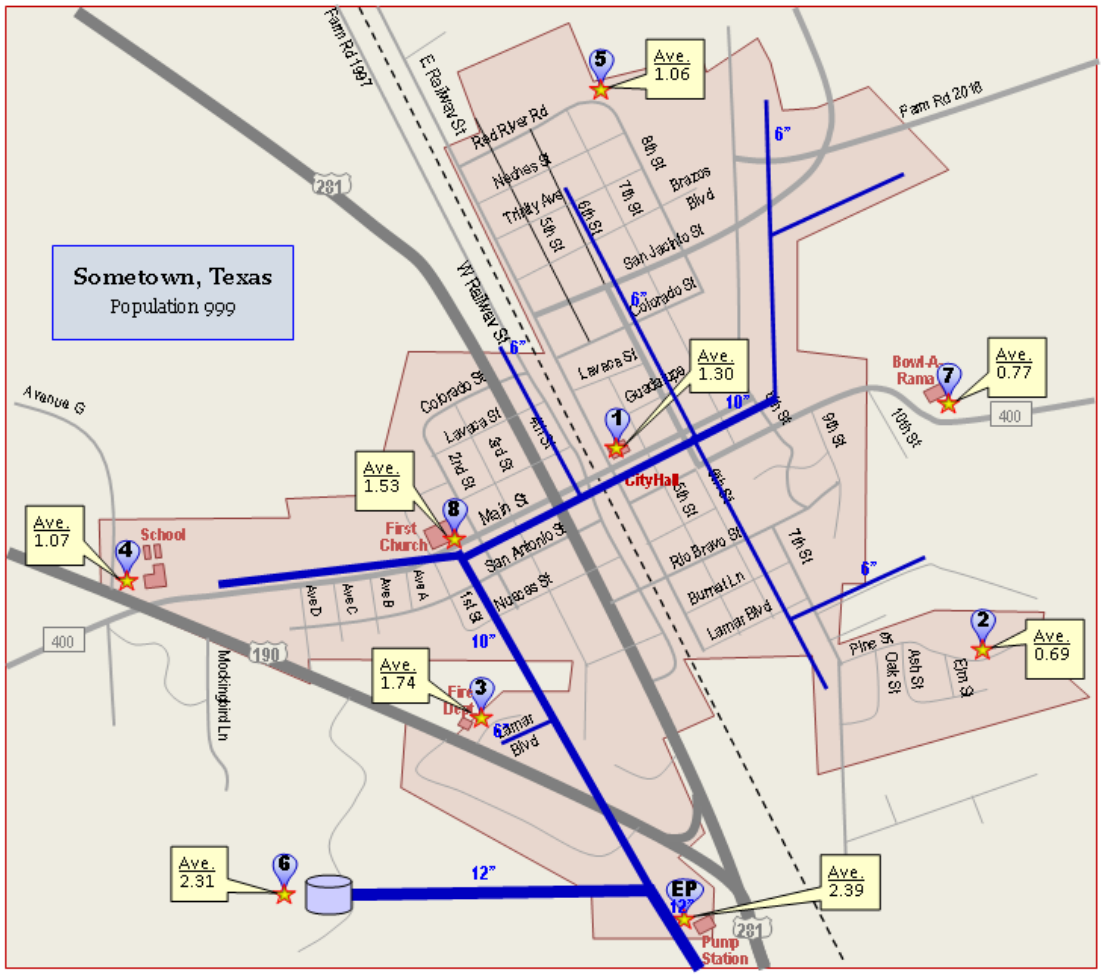
Site # on Map	Address	Sample Tap Location	Water Age	Tap Type	Flush Flow Rate (gal per min)	Calculated Flush Time (min)
EP	281 Pump Station	Tap on Pump 1	Source (0)	Hose bibb	5	5
1	55 E Railway St	Tap by City Hall parking lot	Average	Hose bibb	5	15
2	935 Pine St	Tap in back of house	High	Hose bibb	2	15
3	200 W Lamar Blvd	Fire Department tap by door	Low	Hose bibb	10	5
4	800 W Hwy 190	Tap left of front door of School	Average	Flush valve	5	5
5	700 Red River Rd	Left side of garage	High	Hose bibb	5	5
6	Hill Top Tank	Tap on north side of GST	Storage	Hose bibb	20	5
7	1164 E CR 400	Bowl-a-Rama tap by parking lot	High	Hydrant ID 46	1000	0 (on/off)
8	10 W Main St	First Church - tap left of door	Average	Hose bibb	3	10

Example data from one week is shown in the following table.

One week of disinfectant residual from Sometown, Texas.

Site # on Map	Date							Min	Max	Ave
	4/1	4/2	4/3	4/4	4/5	4/6	4/7			
EP	2.1	3.0	2.5	2.7	1.9	2.1	2.4	1.90	3.00	2.39
Site 1	1.4	1.2	1.6	1.5	1.2	1.1	1.1	1.10	1.60	1.30
Site 2	0.8	0.6	0.7	0.8	0.8	0.6	0.5	0.50	0.80	0.69
Site 3	1.5	1.4	2.1	1.9	1.6	1.7	2.0	1.40	2.10	1.74
Site 4	1.1	1.0	1.2	1.3	1.0	1.1	0.8	0.80	1.30	1.07
Site 5	1.0	0.8	1.4	1.2	1.1	1.0	0.9	0.80	1.40	1.06
Site 6	2.0	2.4	2.8	2.7	2.2	1.9	2.2	1.90	2.80	2.31
Site 7	0.9	0.7	0.8	0.9	0.8	0.7	0.6	0.60	0.90	0.77
Site 8	1.7	1.4	2.0	1.7	1.4	1.3	1.2	1.20	2.00	1.53

The map for Sometown, Texas is shown below.



Example distribution map for Sometown, Texas

Questions for consideration:

In the map above, only the averages are noted. Does this draw the attention to the worst-case site? Would it be helpful to also note the minimums?

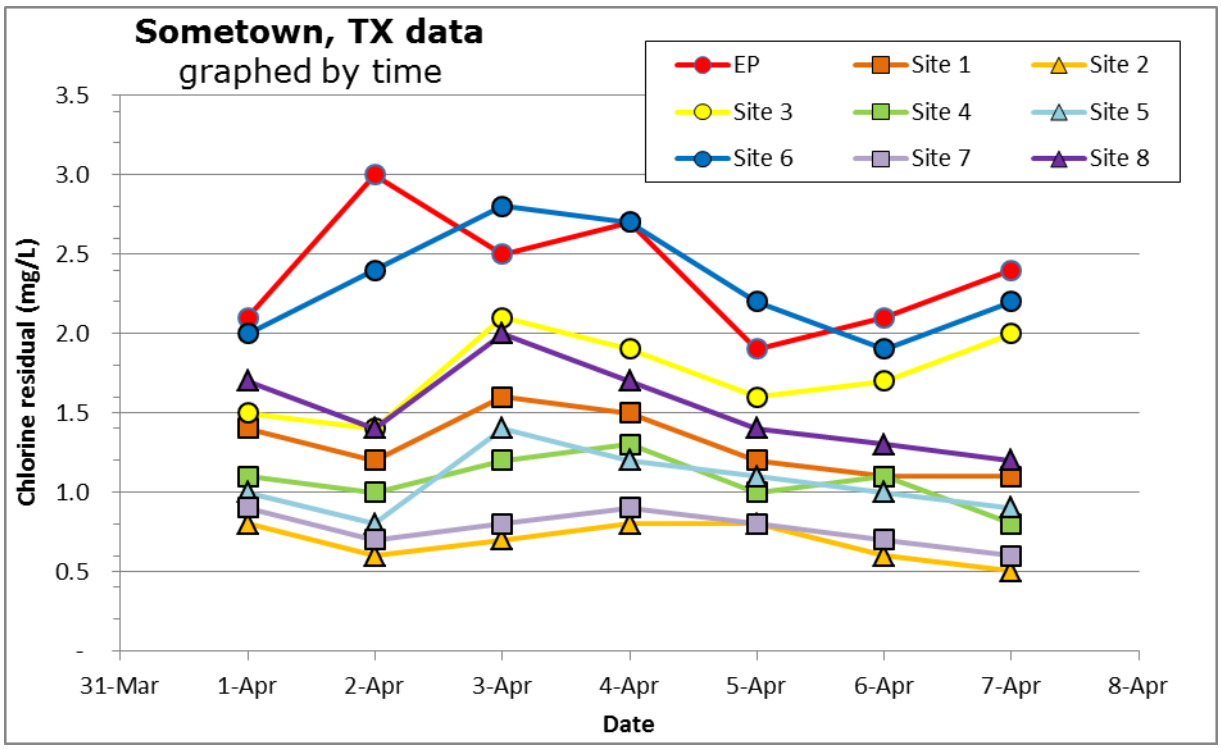
Which site is the worst-case site? Are there other areas in the system which ought to be sampled just to see if they also have low residuals?

Graphing

Another way to visualize what is going on with disinfectant residual is by graphing the data. The two main ways to do this are either by time or location.

Graphing over time

When looking at a graph over time, you are usually looking for trends at a single site—or comparing the trends for various sites.



Graph of Sometown, TX example data over time

In the above graph, we can draw some conclusions. For example, the residual at the Hilltop Tank (Site 6) responds to changes at the entry point (EP) after a lag of about a day.

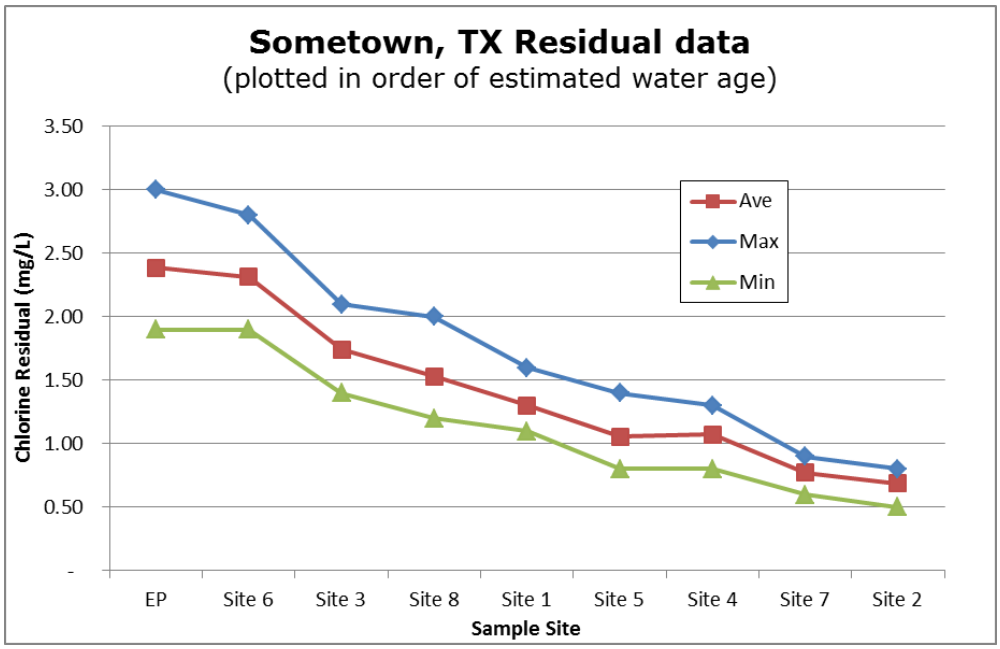
Locational graphing

With locational graphing, you may be looking for trends related to water age, and comparing those for different locations, or just trying to figure out what the water age is.

In the following graph, the data was sorted by chlorine level from highest to lowest. Since chlorine level corresponds to water age, the site with the lowest water age comes first, and the site with the highest water age comes last.

In this example, we see that Site 2, Pine St., appears to be the highest water age. When we look at the map to see if this makes sense, it kind of does. Pine St. is close to the entry point as the crow flies, but following the pipes—it looks like the water takes a while to get there.

This graph shows that Site 2 is the worst-case site, because it has the lowest residuals.



Example of locational graphing for chlorine residual

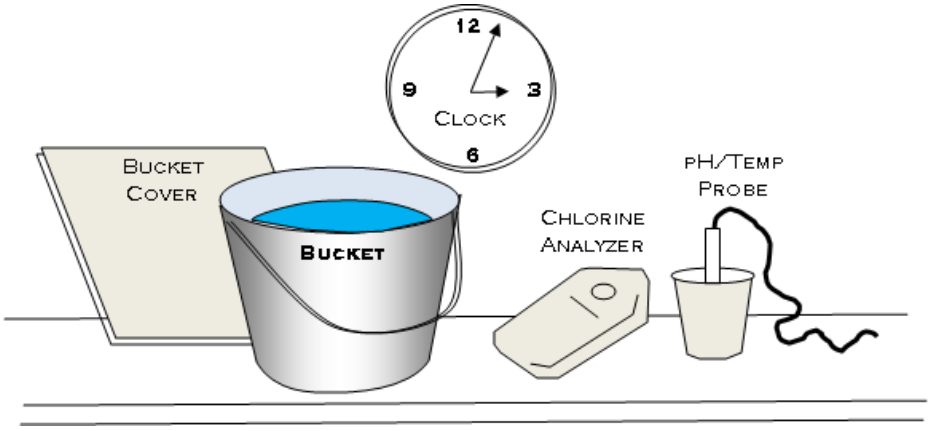
Bucket test for ideal chlorine decay

When looking at the results of distribution system testing, the question may arise: "What SHOULD it be?" One way to evaluate what the ideal residual would be is to do a simple 'bucket test.'

The principle is that chlorine decays in a very predictable way when there are not confusing elements like biofilm, rotting pipes, etc. The chlorine decay test is straightforward. Basically:

- Get a **bucket of water** from the PWS entry point of interest.
  - Use a clean bucket, and rinse it out with entry point water before filling it up.
- Measure the **chlorine, pH, and temperature** at the time of collection.
  - Note the **time**—the time of collection is **t=0** for the test
- Set the bucket somewhere you can generally **control temperature** and contamination.
  - **Cover the bucket** so that stuff does not fall in, and to keep it dark.
- **Measure chlorine, pH, and temperature over time**, till the chlorine is gone.
  - Free chlorine will last a few days. Chloramines will last for weeks. This example talks about free chlorine.
- **Graph** the results.

The figure below shows what you need for a free chlorine decay bucket test.



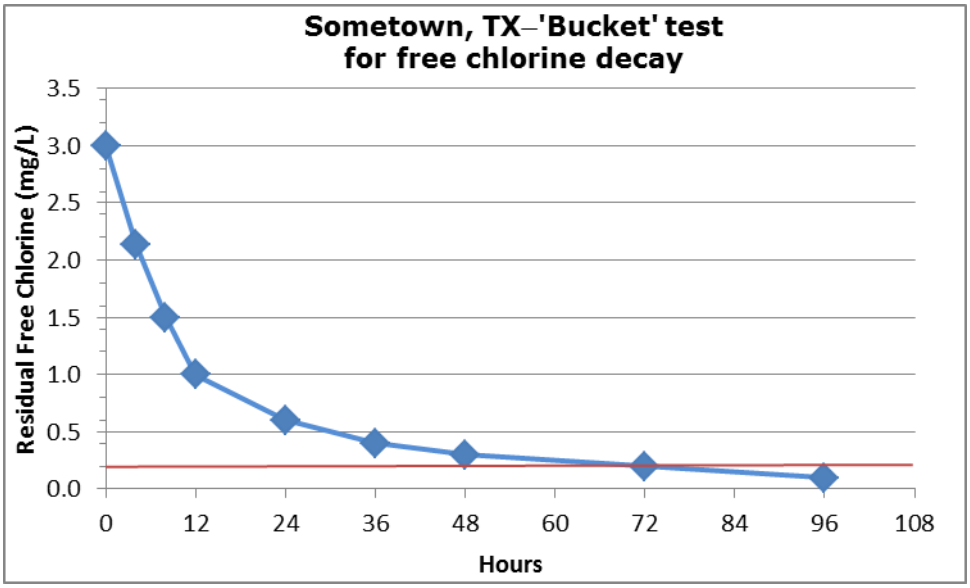
Equipment for a free chlorine decay bucket test

Some example data for a chlorine decay test at Sometown, TX is shown in the following table.

Chlorine decay 'bucket test' data for Sometown, TX example

Hours	0	4	8	12	24	36	48	72	96
Residual (mg/L)	3.0	2.1	1.5	1.0	0.6	0.4	0.3	0.2	0.1
pH	7.8	7.7	7.9	7.8	8.0	7.8	7.9	7.7	7.7
Temp. (F)	92	87	80	72	73	75	74	72	73

A graph of this data is shown below. Note that this shows the normal exponential decay, with rapid decay at first, followed by slower decay later. This is called 'first-order' decay. Practically speaking, what this means is that you need to take more samples at the beginning than at the end to get a complete graph.



Sometown, TX chlorine decay data from bucket test

From this graph, we can see that the longest water age in Sometown, TX is approximately 30 hours, under minimum residual conditions at Sites 2 and 7.

Disinfecting pipes after repair and/or construction

This guidance is provided as a teaching tool to augment the American Water Works Association standards required by TCEQ rule. If any unintended discrepancies between this text and those standards exist, follow the standards.

The primary means of ensuring the sanitary integrity of a main are:

- Sanitary handling of materials,
- Sanitary and appropriate practices during construction, and
- Continual inspection of work.

Construction disinfection—scope and planning

This procedure describes important considerations for flushing and disinfecting pipelines when constructing drinking water distribution facilities:

- Supervision,
- Gathering materials and equipment,
- Disinfection procedure

Planning

The supervisor and crew should have written documentation of work to be done—the area/lines to be repaired—including when an emergency work order is needed. The supervisor and manager should review the planned activities together before starting work. During this planning, the presence of needed staff, equipment, and chemicals should be verified.

Supervision

Consult with the TCEQ regarding the regulatory interpretation of 'direct supervision.' Drinking water industry best practice includes strong oversight of construction and repair because of the high risk of contamination present. Best oversight would take the form of assigning a licensed, on-site supervisor.

Knowledge of disinfection.

Chlorine disinfection and de-chlorination should be performed under the direct supervision of someone familiar with the physiological, chemical, and physical properties of the form of chlorine used.

AWWA Standards B300 and B301 contain information and additional reference material regarding the safe handling of hypochlorite and liquid chlorine. Before overseeing pipeline work, the supervisor shall review this information.

Emergency response.

The direct supervisor should be trained and equipped to handle any emergency that may arise following the PWS procedures and protocols.

The supervisor should ensure that all personnel involved observe appropriate safety practices to protect working personnel and the public. The supervisor should review safety procedures with workers prior to starting any work—especially trench, tank, and gas chlorine work.

Regulatory compliance

The supervisor is responsible for ensuring regulatory compliance. This includes ensuring that:

- Customers are informed of the construction and informed of the need to boil or not use water until the work is finished;
- Appropriate coliform samples are collected;
- Bacteriological sample submission forms for post-disinfection sampling are completed correctly (marked 'construction'); and
- Customers are informed when the work is complete (in the same manner that they were informed that the work was starting.)

Materials and equipment

Chlorine

Enough liquid and/or solid chlorine to disinfect all of the targeted area's pipelines and appurtenances should be obtained.

Liquid

Liquid chlorine contains 100% available chlorine and is packaged in steel containers, available in 100-lb, 150-lb, or 1-ton net chlorine weight. Liquid chlorine shall be ANSI/NSF 60 approved.

Solid

Calcium hypochlorite is available in granular form or in approximately 5-gram tablets, and contains approximately 65% available chlorine by weight. Solid hypochlorite material should be stored in a cool, dry, and dark environment to minimize its deterioration.

Solid hypochlorite chemicals must be ANSI/NSF 60 approved.

Disinfecting Water Mains.

Four methods of chlorination are described:

A. Continuous feed,
B. Slug,
C. Tablets, and
D. Spray disinfection for large transmission mains.

The third method, using tablets of hypochlorite, should never be used for projects of 2,000 feet or more. AWWA Standard C651 may be helpful in determining the best method to use.

Prepare the pipes

For all methods, all pipelines shall be pressure and leak tested, flushed, and cleaned of debris and dirt before applying the disinfectant. At least one pipe-volume of water should be flushed through—for example, if the pipe volume is calculated to be 10,000 gallons, at least 10,000 gallons of water should be flushed through.

If flushing is a problem for any reason, and one volume of water can't be flushed through, that condition will be documented in a manner that can be reviewed by management and regulators if needed. For example—it may be documented on the flushing report or on the Work Order Completion document.

A. Continuous Feed Method

Set-up

The continuous feed method consists of completely filling the main with potable water to remove all air pockets, flushing the completed main to remove particulates, and then refilling the main with potable water that has been chlorinated to 25 mg/L. After a 24-hour holding period in the main, there should be a free chlorine residual of not less than 10 mg/L in collected samples.

Chlorine can be applied in advance of preliminary flushing by swabbing joints with bleach or placing calcium hypochlorite granules in the pipe in areas where contamination is suspected. In that case, action must be taken to make sure that the flushed water is dechlorinated and disposed of in compliance with TCEQ requirements.

Preliminary flushing

Prior to being chlorinated, fill the main to eliminate air pockets and flush to remove particulates. The flushing velocity in the main should not be less than 3 fps unless there are limitations for disposing of flushed water. Table 1 shows the rates of flow required to produce a velocity of 3 fps in pipes of various sizes.

NOTE: Flushing is no substitute for preventive measures during construction. Certain contaminants such as caked deposits resist flushing at any feasible velocity

Table 1: Flow and openings to flush pipes (assuming 40 psi in main)*

Pipe Diameter (inches)	Flow Required to Produce 3 ft/sec velocity in main (gpm)	Size of Tap, (inches)			Number of 2½-inch Hydrant Outlets to Use
		1	1-1/2	2	
		Number of taps on Pipe †			
4	120	1	-	-	1
6	260	-	1	-	1
8	470	-	2	-	1
10	730	-	3	2	1
12	1060	-	-	3	1
16	1880	-	-	5	1

*With a 40 psi pressure in the main with the hydrant flowing to atmosphere, a 2½-inch hydrant outlet will discharge approximately 1,000 gpm and a 4½-inch hydrant outlet will discharge approximately 2,500 gpm.
† Number of taps on pipe based on discharging through 5 feet of galvanized iron pipe (worst case) with one 90° elbow.

Broom sweeping

In mains of 24-inches or larger diameter, an acceptable alternative to flushing is to broom-sweep the main, carefully removing all sweepings prior to chlorinating the main.

OSHA requirements for confined space need to be addressed prior to entering a pipeline.

Continuously chlorinating the main

Potable water should be supplied to the chlorinator from a temporary backflow-protected connection to the existing distribution system. The cross connection control device shall be consistent with the degree of hazard for backflow protection of the active distribution system.

The flow should be at a constant, measured rate into the newly installed water main. In the absence of a meter, it is possible to approximate the rate by placing a Pitot gauge in the discharge or measuring the time to fill a container of known volume. The main should undergo hydrostatic pressure testing prior to disinfection.

At a point not more than 10 feet downstream from the beginning of the new main, dose the water entering the new main with chlorine fed at a constant rate such that the water will have not less than 25 mg/L free chlorine.

Measure the chlorine concentration at regular intervals to ensure that this concentration is provided. Measure chlorine in accordance with the procedures described in the current edition of the AWWA Manual M12 or of Standard Methods for the Examination of Water and Wastewater.

Chlorine per 100 feet of pipe

Table 2 gives the amount of chlorine required for each 100 feet of pipe of various diameters. Solutions of 1 % chlorine may be prepared with calcium hypochlorite. The solution requires 1 pound of calcium hypochlorite in 8 gallons of water.

Table 2 Chlorine needed to produce 25 mg/L concentration in 100 feet of pipe, by diameter

Pipe Diameter (inches)	100% Chlorine (lb)	1% Chlorine Solution (gallons)
4	0.013	0.16
6	0.030	0.36
8	0.054	0.65
10	0.085	1.02
12	0.120	1.44
16	0.217	2.60

Valve positions

During the application of chlorine, position valves so that the strong chlorine solution in the main being treated will not flow into water mains in active service. Do not stop the chlorine application until the entire main is filled with heavily chlorinated water. Keep the chlorinated water in the main for at least 24 hours. During this time, operate all valves and hydrants in the section treated in order to disinfect the appurtenances. At the end of this 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine.

Applying hypochlorite solution

Hypochlorite solution may be applied to the water main with a chemical feed pump designed for feeding chlorine solutions. Feed lines shall be of such material and strength as to safely withstand the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. All connections should be checked for tightness before the solution is applied to the main.

Applying gas chlorine

If gaseous chlorine in solution is planned, the preferred equipment for the gas application employs a feed vacuum-operated chlorinator to mix the chlorine gas, in combination with a booster pump for injecting the chlorine gas solution water into the main to be disinfected. Direct feed chlorinators cannot be used. (A direct feed chlorinator is one which operates solely from the pressure in the chlorine cylinder.)

B. Slug Method

Set-up

The slug method consists of placing calcium hypochlorite granules in the main during construction; completely filling the main to eliminate all air pockets, flushing the main to remove particulates, and slowly flowing a slug of water containing 100 mg/L of free chlorine through the main so that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 hours.

Chlorinating the main.

Potable water may be supplied from a temporary backflow-protected connection to the existing distribution system or other supply approved sources. The cross connection control device should be consistent with the degree of hazard for backflow protection of the active distribution system.

The flow should be at a constant, measured rate into the newly installed water main. A meter, Pitot gauge, or timing a bucket filling can be used to determine discharge flow. The main should undergo hydrostatic pressure testing prior to disinfection.

At a point not more than 10 feet downstream from the beginning of the new main, dose the water entering the new main with chlorine fed at a constant rate such that the water will have not less than 100 mg/L free chlorine.

Measure the chlorine concentration at regular intervals to ensure that this concentration is provided. Measure chlorine in accordance with the procedures described in the current edition of the AWWA Manual M12 or of Standard Methods for the Examination of Water and Wastewater.

The chlorine shall be applied continuously and for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately 100 mg/L for at least 3 hours.

The free chlorine residual shall be measured in the slug as it moves through the main. If at any time it drops below 50 mg/L, stop the flow, relocate the chlorination equipment to the head of the slug, and as flow is resumed, apply chlorine to restore the free chlorine in the slug to not less than 100 mg/L.

As the chlorinated water flows past fittings and valves, operate related valves and hydrants so as to disinfect appurtenances and pipe branches.

C. Tablet Method

Set-up

The tablet method consists of adhering calcium hypochlorite tablets in the water main as it is being installed and then filling the main with potable water when installation is completed. This method may be used only if the pipes and appurtenances are kept clean and dry during construction for short main installations.

Chlorinating the main

During construction, 5-gram calcium hypochlorite tablets should be placed in each section of pipe. Also, one such tablet shall be placed in each hydrant, hydrant branch, and other appurtenance.

The number of 5-gram tablets required for each pipe section shall be $0.0012\ d^2L$ rounded to the next higher integer, where d is the inside pipe diameter, in inches, and L is the length of the pipe section, in feet. Table 3 below shows the number of tablets required for commonly used sizes of pipe.

TABLE 3 Number of 5-gram calcium hypochlorite tablets required for dose of 25 mg/L based on 3.25 g available chlorine per tablet.

	Length of Pipe Section, ft				
Pipe Diameter	13 or less	18	20	30	40
inches	Number of 5-g Calcium Hypochlorite Tablets				
4	1	1	1	1	1
6	1	1	1	2	2
8	1	2	2	3	4
10	2	3	3	4	5
12	3	4	4	6	7
16	4	6	7	10	13

The calcium hypochlorite tablets shall be attached by an adhesive meeting the NSF/ANSI 61 requirements. There shall be no adhesive on the tablet except on the broadside attached to the surface of the pipe and no adhesive applied or spilled on the pipe surface. Excess adhesive must be removed immediately using mechanical means or an NSF-approved adhesive solvent. Attach all the tablets inside and at the top of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section so it can be readily determined that the pipe is installed with the tablets at the top.

When installation has been completed, the main should be filled with water at a rate such that water within the main will flow at a velocity no greater than 1 fps. Precautions shall be taken to ensure that air pockets are eliminated. Fill rate must be carefully controlled to ensure tablets do not come loose from the pipe. This water should remain in the pipe for at least 24 hours.

If the water temperature is less than 41˚F (5˚C), the water should remain in the pipe for at least 48 hours. A detectable free chlorine residual (≥0.2 mg/L) shall be found at each sampling point after the 24 or 48 hour period.

D. Spray disinfection for large transmission main

For very large transmission mains (where equipment and personnel may safely enter the main), spray disinfection may be appropriate and efficient means of achieving disinfection. For this method, refer to ANSI/AWWA C652, Sec. 4.3.2 (Disinfection of Water Storage Facilities; Chlorination Method 2.) In general, once the pipe is cleaned, spray a 200 mg/L free chlorine solution on all surfaces, allow 30 minutes of contact time, fill line and sample as described above.

Safe disposal of highly chlorinated water

Do not keep heavily chlorinated water in contact with pipe for more than 48 hours after the applicable retention period. In order to prevent damage to the pipe lining or corrosion damage to the pipe itself, flush the heavily chlorinated water from the

main fittings, valves, and branches until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or is acceptable for domestic use.

Take all steps necessary to dechlorinate water where required. Contact the local sewer department to arrange for disposal of the heavily chlorinated water to the sanitary sewer if applicable or permissible. Follow all TCEQ requirements.

Neutralize the chlorine residual of the water being disposed of by treating with one of the chemicals listed in Table 4 below. Select an alternative disposal site if a sanitary sewer system is unavailable for disposal of the chlorinated water.

The proposed alternative disposal site should be inspected and approved by supervisory staff. Apply a reducing agent to the chlorinated water to be wasted to completely neutralize the chlorine residual remaining in the water.

Do not overdose neutralizing chemicals as this may result in adverse environmental impacts. Only dose the amount required to neutralize the amount of chlorine present. Contact the TCEQ Region or Spill Response group, where necessary, to determine special provisions for the disposal of heavily chlorinated water.

TABLE 4 Pounds of chemicals required to neutralize various residual chlorine concentrations in 100,000 gallons of water

Residual Chlorine Concentration mg/L	Sulfur Dioxide (SO_2) lb	Sodium Bisulfite ($NaHSO_3$) lb	Sodium Sulfite (Na_2SO_3) lb	Sodium Thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) lb	Ascorbic Acid ($C_6O_8H_6$) lb
1	0.8	1.2	1.4	1.2	2.1
2	1.7	2.5	2.9	2.4	4.2
10	8.3	12.5	14.6	12.0	20.9
50	41.7	62.6	73.0	60.0	104.0

Test for chlorine residual throughout the disposal process to be sure that the chlorine is neutralized.

If a discharge of chlorinated/chloraminated water will impact waters of the State of Texas, contact the TCEQ Spill Response Hotline at 1-800-832-8224.

Coliform Testing

New mains

It should be recognized that the primary means of ensuring the sanitary integrity of a main are the sanitary handling of materials, the practices during construction, and continual inspection of work. After disinfection and final flushing such that typical system chlorine residuals are present, samples should be collected as follows:

For new mains, two options for the bacteriological testing for total coliform analysis are discussed here.

Option A: Before approving a main for release, take an initial set of samples and then resample again after a minimum of 16 hours using the sampling site

procedures outlined. Both sets of samples must pass for the main to be approved for release.

Option B: Before approving a main for release, let it sit for a minimum of 16 hours without any water use. Then collect, without flushing the main, two sets of samples a minimum of 15 min apart while the sampling taps are left running using the sampling site procedures outlined. Both sets of samples must pass for the main to be approved for release.

A set of samples includes all samples collected along the length of the pipeline, as described below:

- For new mains, sets of samples shall be collected every 1,000 feet (370 m) of the new water main, plus one set from the end of the line and at least one from each branch greater than one pipe length.
- If trench water has entered the new main during construction or if, in the opinion of the supervisor, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 feet (61 m). Samples shall be taken of water that has stood in the new main for at least 16 hours after final flushing has been completed.

A standard heterotrophic plate count (HPC) test may be required at the option of the supervisor because new mains do not typically contain coliform bacteria but often contain HPC bacteria. If sample results show HPC greater than 500 CFU/mL, flushing should resume and another set of HPC and coliform samples collected until no coliform are present and the HPC is less than 500 CFU/mL.

Standard conditions for repaired mains.

For repaired mains that were depressurized and/or wholly or partially dewatered, one set of samples may be required, and depending upon the sanitary conditions, the line may be reactivated prior to the completion of bacteriological testing. Samples should be collected downstream of the repair site and at intervals of approximately 200 feet (61 m) within the length of pipe that was shut down. If direction of flow is uncertain, samples shall be collected on either side of the repair site.

Samples should be collected by a person knowledgeable in collecting samples for bacteriological sampling or arrange for a licensed water operator to collect the sample. Coordinate with a certified laboratory for testing of bacteriological (chemical and physical) quality. Testing should be in accordance with Standard Methods of the Examination of Water and Wastewater. Samples should be measured for total coliform presence/absence, and every total coliform positive should be subsequently, immediately analyzed for *E. coli*. For acceptable results, this measurement should show the absence of coliform organisms; and the presence of a chlorine residual.

Samples should also be tested for turbidity, pH, and standard heterotrophic plate count (HPC). HPC levels should be consistent with levels normally found in the distribution system to which the new main is connected.

Bacteriological tests must show complete absence of coliforms and acceptable HPCs. If tests show the presence of coliform or unacceptable HPCs, perform additional flushing and disinfection of the pipeline until acceptable tests are obtained.

Basic considerations when disinfecting mains after repair or construction

The planned, unplanned, or emergency repair of a water main or appurtenance (e.g., valve) is time sensitive—an important goal is to minimize the disruption of water service to customers. Nonetheless, the repair work needs to be accomplished using sanitary and safe procedures by well-trained crews with proper supervision and guidance. Work should follow basic disinfection and contamination prevention procedures described above in order to accomplish general goals.

Contaminants should be prevented from entering the existing pipe during the repair by maintaining positive pressure in the leaking pipe until the repair site on the pipe is fully exposed, by maintaining a dewatered trench, and by keeping all materials being used in the repair in a clean and sanitary condition. For example, by inspecting, cleaning, and disinfecting with1 % chlorine solution:

- Exposed portions of existing pipe interior surfaces,
- Pipe materials used in the repair, and
- Handheld materials and tools used to make the repair.

Communication with customers is the best way to retain trust. As appropriate, customers should be advised to boil or not use water, then to advise them in the same manner when the water can be used again, and remind them to adequately flush their lines upon return to service.

Selection of disinfection procedure.

The disinfection procedure selected should be determined by the conditions and severity of the main break. Many leaks or breaks can be repaired under controlled conditions without depressurizing the water main, such as when applying a clamp to a small crack or hole, thus preventing contaminants from entering the water system. In most other situations, the water main can be maintained pressurized until the break site is secured and the pipe is fully exposed.

Some circumstances (e.g., severe erosion of the local environment or icing of the roadway) that impact public safety may require that water pressure be substantially reduced prior to exposing the pipe in the area of the leak. In some cases, situations become catastrophic where there is a pipe blowout and a loss of water pressure prior to shutdown, requiring disinfection procedures equivalent to those of a new main installation.

The procedures below describe the contamination risks and the associated disinfection and sampling requirements for different scenarios of pipeline repair. Specific situations not captured below need to be evaluated and the appropriate disinfection and sampling methods followed.

Pipe repair

Controlled pipe repair without depressurization

In this situation, activities are well controlled and a full shutdown is not needed, thus maintaining positive pressure to the area of shutdown and around the break site at all times. The repair site is exposed and the trench is adequately dewatered so that the repair site can be cleaned and disinfected by spraying or swabbing with a minimum 1 percent chlorine solution. The water main is then returned to service with flushing to obtain three volumes of water turnover, making sure that the flushed water is visually clear.

Controlled pipe repair with depressurization after shutdown

In this situation, after the repair site has been exposed and secured from trench soil/ water contamination, the water main is depressurized by a shutdown to complete the repair. The repair site should be cleaned and disinfected by spraying or swabbing with a minimum 1% chlorine solution.

The water main is then returned to service with flushing to scour the pipe and obtain three volumes of water turn- over, making sure that the flushed water is visually clear. Check for a the minimum required chlorine residual, and if not found, to continue flushing until residuals are restored to levels maintained in the distribution system by the PWS.

When the existing pipe has to be opened and the interior surfaces of the water system exposed to the environment, additional procedures need to be followed. The existing pipe should be inspected and cleaned with the help of flushing water into the trench, where possible, until the flush water runs visually clear. The repair site should be accessible and the trench adequately dewatered so that the repair site can be cleaned and disinfected by spraying or swabbing with a minimum 1% chlorine solution.

Additionally, any accessible upstream and downstream interior of the existing pipe should be disinfected by swabbing or spraying with a minimum 1 % chlorine solution. If the repair requires a full pipe section replacement, the new pipe should be inspected, cleaned, and disinfected from both ends by swabbing with a minimum 1% chlorine solution. The water main may then be returned to service after flushing to scour the pipe and obtain three volumes of water turnover.

The flushed water should run visually clear, have chlorine residuals greater than the required minimums, and be checked with bacteriological testing.

Uncontrolled pipe break with a likelihood of water contamination or loss of sanitary conditions during repair.

In situations in which the existing main to be repaired could not be protected and kept free of contamination and there are obvious signs of contamination (e.g., muddy trench water flowing into the broken pipe and a leaking sewer pipe in the trench, or catastrophic pipe failure where pipe is open and there is a likelihood that contamination was drawn into the active system) or when a controlled repair

situation turns into a situation in which the internal pipe and water have become contaminated, the procedures outlined above should be followed where practical.

These methods specify chlorine doses of 25–300 mg/L; however, such levels may present greater harm if the line or services cannot be reliably isolated or shut down and exposure of customers to high concentrations of chlorine cannot be controlled. Chlorine residuals up to 4 mg/L are suggested as a minimum to be maintained for at least 16 hours in conjunction with flushing, coliform sampling, and associated customer education.

Notes

Appendix 4. Nitrification

Nitrification in drinking water distribution systems with chloramines can cause rapid decreases in disinfectant residuals, which in turn can cause TC+.

Scope

This appendix provides more help on nitrification.

Nitrification is a complex problem, and can be difficult to fix. If an assessor is not an expert on chloramination and nitrification, they should seek training and/or expert assistance.

Documents and data

A PWS that has the potential to have chloramines present is required to have:

- Minimum residual compliance data for total chlorine;
- Chloramine-effectiveness monitoring data for total chlorine, monochloramine, and free available ammonia;
- Nitrification-detection data for (at least) nitrite and nitrate; and
- A Nitrification Action Plan.

Additional process management data may also be available.

Resources

Twenty years ago, as more systems turned to chloramines to solve disinfection byproducts issues, the unintentional consequence of nitrification became a challenge. Since that time, numerous resources have become available.

EPA

EPA Distribution System Issue Paper (DSIP) "**NITRIFICATION**"

www.epa.gov/sites/production/files/2015-09/documents/nitrification_1.pdf

Web site: Basic Information about Chloramines and Drinking Water Disinfection

www.epa.gov/dwreginfo/
basic-information-about-chloramines-and-drinking-water-disinfection

TCEQ

The TCEQ provides free, on-site training. Directed Assistance Module (DAM) 8 can be requested by contacting the TCEQ Financial, Managerial, and Technical (FMT) program at 512-239-4691, or visiting the web at:

www.tceq.texas.gov/drinkingwater/fmt

Web site: Controlling Nitrification in Public Water Systems with Chloramines

www.tceq.texas.gov/drinkingwater/disinfection/nitrification.html

AWWA

M56 "**NITRIFICATION PREVENTION AND CONTROL IN DRINKING WATER**"

www.awwa.org/store/productdetail.aspx?productid=34630881

Nitrification Action Plan

A PWS that has and follows an adequate NAP should be aware of a nitrification event essentially from its beginning. The core concept of a NAP is to be alert for changes that might indicate nitrification. The required chemicals used for NAP monitoring are:

- Total chlorine,
- Monochloramine,
- Free available ammonia (as nitrogen),
- Nitrite (as nitrogen), and
- Nitrate (as nitrogen).

The NAP also may include monitoring for:

- pH,
- Chlorite,
- Heterotrophic plate count bacteria, and/or
- Other indicators.

When it comes to nitrification, one size does not fit all. Each system's goals, baselines, and triggers in the NAP will be unique.

Review the data to determine if any indicators of nitrification confirmed its presence. For example, lower- than-normal ammonia, increase or decrease in nitrite, increase in nitrate, pH drop, or any site-specific indicators identified in the NAP—such as microbial testing.

Nitrification is much harder to stop once it has started than it is to manage before it has had a chance to begin. A NAP is used to keep nitrification from getting out of control.

Successful use of a NAP requires coordination, cooperation, and communication between staff of different areas and their managers. These communication pathways are crucial in efforts to prevent nitrification from occurring or eliminating it once it has developed. Failure to document sampling and operational actions and to properly maintain the documents can prevent the system from stopping nitrification before it gets bad.

Failure to have a Nitrification Action Plan is a violation of §290.46(z).

Failure to control nitrification by implementing a good prevention plan may result in nitrification causing low residuals and TC+ which may lead to violations. Be prepared to provide data to TCEQ upon request; keep documentation for review during future inspections.

Temporary conversion to free chlorine

A conversion to free chlorine involves a great deal of work in the distribution system—turning and isolating valves, flushing hydrants, and monitoring water quality. In that process, changes in flow and pressure may stir up sediment resulting in TC+ samples resulting from significant changes in water quality.

Collecting routine coliform samples when the system is in the process of transitioning from free chlorine to chloramines—or back again—may influence results. Avoid collecting bacteriological samples in an area that you have recently flushed very heavy. Give the area some time to settle back down before collecting a sample there.

Always notify TCEQ at ***DBP@tceq.texas.gov*** before doing a temporary conversion to free chlorine.

If an issue is found, the PWS should review the procedures for free chlorine conversions to make sure that the process for switching to free chlorine, and then back to chloramines, is well documented and that staff follow the procedures.

Notes

Appendix 5. Cross-connection control

Vulnerability to cross-connection-type contamination from pathogens (backflow events) is the most common sanitary defect that leads to potential health concerns at PWSs in the US.

Scope

This appendix discusses cross-connection control which is related the last barrier against the entry of contaminants into drinking water—protecting finished water from being contaminated with pathogens or chemicals by implementing a cross-connection control program (CCCP).

Documents and data

A PWS's Cross-Connection Control program documents the status of known hazards, and has systems in place to identify (as-yet) unknown hazards.

Some of the useful documents include:

- ✓ Distribution map and yellow pages, and
- ✓ Retail Service Agreement.
- ✓ Commercial service agreements, or certificates of occupancy (if used to accomplish right-of-entry for CSIs);
- ✓ Cross-connection control program documentation;
- ✓ Plumbing ordinance (if present);
- ✓ SOPs—for example, SOPs for CSIs.

Resources

Cross-connection control has long been recognized as a necessary activity at PWSs. Many resources exist.

EPA

EPA provides distribution guidance at:

www.epa.gov/dwcapacity/distribution-resources-small-drinking-water-systems-0

This guidance includes free downloads:

- **"CROSS-CONNECTION CONTROL: A BEST PRACTICES GUIDE"** (EPA 816-F-06-035)
  - This Guide discusses the importance of controlling cross-connections and preventing backflow occurrences from unprotected cross-connections in the water system.
- **"CROSS-CONNECTION CONTROL MANUAL"** (EPA 816-R-03-002)
  - This Cross-Connection Control Manual has been designed as a tool for health officials, waterworks personnel, plumbers, and any others involved directly or indirectly in water supply distribution systems.

TCEQ

The rule requirements for cross connection, backflow, and backsiphonage prevention are in the TCEQ rules in §290.41, §290.44 and §290.46. TCEQ provides guidance in

- Regulatory Guidance-478 (RG 478) "**ESTABLISHING AND MANAGING AN EFFECTIVE CROSS-CONNECTION CONTROL PROGRAM**" and
- RG-206 "**A PUBLIC WATER SYSTEM GUIDE TO CUSTOMER SERVICE INSPECTIONS**."

USC

Best practices for PWSs are given in "**MANUAL OF CROSS CONNECTION CONTROL, TENTH EDITION**" by the University of Southern California, 2009, available from the University of Southern California

AWWA

"**BACKFLOW PREVENTION AND CROSS-CONNECTION CONTROL: RECOMMENDED PRACTICES (M14) FOURTH EDITION**" 2007, available from the American Water Works Association. Portions of the International Plumbing Code and Uniform Plumbing Code reference backflow prevention and cross-connection control practices, and may also be useful.

Cross Connection Control: The final barrier

The final barrier protecting customers from hazardous chemicals and waterborne pathogens in the distribution system are maintaining adequate disinfection residuals and a robust and effective Cross Connection Control Program. When contamination enters the distribution system via backpressure or backsiphonage it bypasses the more robust disinfection treatment at the treatment plant.

As a result, it puts the customers at a higher risk for waterborne illness as the water has a more direct route to customers' taps. When cross-connections occur, they significantly reduce the contact time that the disinfection has to react and inactivate or remove hazardous chemicals or microbes.

The PWS's Role

The PWS is responsible for overseeing and/or participating in the activities that protect public health from backflow events.

What is a CCCP

The goal of an adequate Cross-Connection Control Program (CCCP) is to protect drinking water customers from potential contamination caused by cross-connection, backflow, and/or backsiphonage.

The PWS's role begins with good system maintenance and sound operations. By replacing pipes before they break, taking steps to ensure that system pressures do not fall during periods of high demand, and asking for the cooperation of customers when there is a risk that system pressures could fall below safe levels, your public water system operator reduces the risk of backflow.

CCCPs identify locations where the risk of cross connection is high and ensure that the proper measures are taken to minimize that risk. For example, these and other businesses would be required to install high-grade backflow prevention assemblies and have them tested by a certified tester annually:

- mortuaries
- minor surgery centers
- hospitals
- chemical plants

Customer service inspections (CSIs)

Another aspect of an effective CCCP is the customer service inspection (CSI). The PWS must require a CSI to be performed under the following circumstances:

- All new construction.
- Existing customers that have had substantial plumbing modifications.
- Existing customers whenever there is a reason to suspect that a hazard or a source of contamination may be present.

PWSs notify their customers that a CSI is required. Some PWSs have licensed staff who perform the CSIs and then bill the customer for the inspection. Other PWSs require the customer to hire a licensed person to conduct the CSI. The following individuals are authorized to perform CSIs:

- A TCEQ-licensed Customer Service Inspector.
- A Texas State Board of Plumbing Examiners (TSBPE) licensed Plumbing Inspector.
- A TSBPE-licensed plumber with a Water Supply Protection Specialist endorsement.

The TCEQ's Occupational Licensing Section licenses Customer Service Inspectors and maintains a database of licensed Customer Service Inspectors.

Adequate backflow prevention at PWS interconnections

The assessor should be cognizant of potential downstream concerns from purchased water connections. Usually, these interconnections are through an air gap, sometimes through valves that provide backflow protection (double checks) or backflow prevention devices, and rarely, PWS are directly interconnected. The last, rarest, case is the one which would have the greatest vulnerability to backflow.

Note that, although an air gap can't be tested, it can be inspected. An air gap can become non-functional in various ways, including insect or rodent infestation.

If water from an interconnection was vulnerable to backflow or cross-connection, the Assessor should consult with TCEQ.

If backflow from an interconnection occurred, it should be described as an Additional Issue.

Cross-connections in the chemical feed facilities

The assessor should be able to determine whether the system's chemical feed is vulnerable to cross connection if treated water is used to make up chemicals which feed to an upstream stage in treatment without backflow protection.

Review the chemical feed piping and compliance documentation.

Assess whether the chemical feed piping and chemical makeup water need to be re-plumbed to ensure that no cross connections are present that could allow chemicals or untreated water to enter the distribution system.

If cross connection is a vulnerability for the chemical feed facilities, that should be described in the Additional Issues, as well as any steps taken to fix it.

Backflow prevention authority (service agreement and/or plumbing ordinance)

Every PWS is required to implement cross connection control through either a

A **large** system that is a municipality serving more than 5,000 people must have **a plumbing ordinance** that adopts a plumbing code (IPC or UPC), which includes restrictions on plumbing, lead-containing materials, and provision of backflow protections where a hazard exists. Sometimes, the document used to ensure implementation of appropriate backflow prevention at these systems is called a Service Agreement. Other times it is called a Certificate of Occupancy, or other title.

A **small** system that is not a municipality or is a municipality serving fewer than 5,000 people must have a **Service Agreement** with each customer which ensures the right-of-entry for inspection, the installation of backflow prevention devices if hazards are present, and the use of lead-free plumbing materials. [§290.47]

An industrial or **non-conventional** PWS such as a jail must protect against backflow and cross connection in order to protect public health. The components of a cross-connection control program in one of these PWSs will look different than for communities. For example, in an industrial facility or jail, the cross-connection control activities would likely be under the environmental of facility maintenance section.

If the PWS does not have a way of controlling the hazards in the service area, that should be corrected. If the process exists, but is not documented well enough to assess, the documentation procedures should be updated.

If cross connection is a vulnerability because of inadequate protection against hazards at customer facilities, that should be described in the Additional Issues, as well as any steps taken to fix it.

Appropriate backflow prevention at all connections with potential hazards

A successful Cross-Connection Control Program includes oversight of hazards in the PWS's service area. For example, some cities review business records for the area and periodically contact those that may have hazards, and/or review the need for backflow prevention at the time a certificate of occupancy is issued. Other PWSs may have other strategies.

Appropriate backflow prevention methods depend on the hazard that they are protecting against, and where they are installed. There are many varieties of backflow prevention—some types include:

- Reduced-pressure principle backflow preventer,
- Check valve,
- Air gap.

The assessor ought to determine whether the PWS ensures that backflow preventers are installed and functional at connections with hazards. If no such oversight by the PWS exists, that failure could contribute to contamination anywhere in the system connected hydraulically with hazardous sites or facilities.

A program should be implemented to make sure that backflow preventers are tested annually where needed. The program should perform internal and external outreach to educate PWS staff and customers on the importance on backflow preventer testing and maintenance. The PWS should keep records of locations of hazards and their backflow prevention strategy.

If cross connection is a vulnerability because of inadequate protection against hazards at customer facilities, that should be described in the Additional Issues, as well as any steps taken to fix it

Private wells or rain water collection systems

One frequent way that distribution systems are contaminated is by homes with private wells. Less frequently, but more so since the drought, rainwater collection systems can cause system contamination.

Homes that have private wells may have had those wells drilled decades ago, and the wells were not drilled to stringent PWS standards. Also, the water is usually not disinfected. Therefore, those private wells are highly likely to contain pathogens. When a house has water coming from both a private well and the PWS, any decrease in distribution pressure can suck that well water in and contaminate the distribution system.

Rain water collection is more popular in Texas since the recent drought. Rain water is essentially surface water; it contains pathogens from the roof, which is open to animal feces, particularly birds. Therefore, if a home has both rain water collection and a connection with the PWS, the PWS is at risk of potential contamination.

If any connections in the area have a private well or rain water collection system, the assessor should attempt to find out whether the PWS ensures backflow preventers are installed and functional.

If backflow prevention at connections with wells or rain water collection is an issue, that should be described in the Additional Issues.

Septic systems and lawn irrigation

When septic systems and irrigation systems are located in the same vicinity, a high risk of cross connection is present.

If any connections in the area have a private well or rain water collection system the PWS should ensure backflow preventers are installed and functional. The PWS should ensure that the distribution system is protected and also provide outreach to the customer about the internal risk.

Backflow events

A backflow-type event includes:

- Cross-connection,
- Backsiphonage, or
- Backflow.

Review the distribution system map. Consider hazards that might be present in the area of where the TC+ occurred. Check the area to see if conditions favorable to cross connection, backflow, or backsiphonage could have happened.

If a cross contamination event occurred and was identified while it was happening, the PWS should have responded appropriately with disinfection, flushing, and requirements for backflow devices and/or internal programs where appropriate.

If cross contamination occurred but was not identified immediately and is ongoing, some response such as notification of customers with information to protect public health (for example a 'boil water' or 'do not use' notice) should be provided.

Failure of a backflow prevention assembly

If a hazard (for example, cattle or a septic field) exists at a connection that is protected by a backflow prevention assembly, if the device failed it could have allowed contamination to enter the distribution system.

If failure of a backflow prevention assembly (or air gap, check valve, etc.) caused a cross connection, backflow, or backsiphonage event, the PWS should take steps to fix it.

Customer Service Inspection

A Customer Service Inspection is a useful process for identifying hazards that could cause degradation of distribution water quality.

It is best practice to perform a Customer Service Inspection was performed at any sites with TC+ to identify any potential pathways for pathogen contamination.

It may be also useful to schedule a Customer Service Inspection for any active services in the vicinity of the TC+. If a hazard is found through that inspection, it should be corrected.

Workshop 6 activities

Evaluating the possible impact of cross-connection or backflow

Determine the extent and completeness of the PWS's overall CCCP, including the adequacy of its ordinance or service agreement.

Assess how Customer Service Inspections are implemented at the system and note whether one was performed at any locations where a TC+ occurred.

Appendix 6: Corrosivity

Corrosive water can eat away metal pipes, causing a higher risk of intrusion from the soil around the pipe. That soil may contain pathogens.

Tubercular plating in an iron pipe

Scope

This appendix discusses corrosivity which can cause leaks that are sanitary defects. Remember: **"If it leaks out, it can leak in!"**

Documents and data

Depending on the size of the system, there may be more or less data available.

- ✓ Distribution map—for example, lead copper sites,
- ✓ pH, alkalinity, and other data
  - From water quality parameter monitoring, for large systems, or
  - From mineral samples, for small systems, and
- ✓ Operators observation of pipes during repairs.

Resources

The EPA Lead and Copper Rule (LCR) regulates water corrosivity indirectly through tap sampling, and directly, through water quality parameter sampling at sources, entry points, and in distribution.

Additional EPA resources are on the web at:

www.epa.gov/dwreginfo/optimal-corrosion-control-treatment-evaluation-technical-recommendations

AWWA

M58 "INTERNAL CORROSION CONTROL IN WATER DISTRIBUTION SYSTEMS"

www.awwa.org/store/productdetail.aspx?productid=61156111

M27 **"EXTERNAL CORROSION CONTROL FOR INFRASTRUCTURE SUSTAINABILITY"**

www.awwa.org/store/productdetail.aspx?productid=36972484

Articles

"**DRINKING WATER PROBLEMS: CORROSION**," by McFarland, Provin, and Boellstorf, at

twon.tamu.edu/media/385808/drinking%20water%20problems-corrosion.pdf

"**DRINKING WATER ISSUES CORROSIVE WATER (LEAD, COPPER, ALUMINUM, ZINC AND MORE)**" Brian Oram, PG, at

www.water-research.net/index.php/drinking-water-issues-corrosive-water-lead-copper-aluminum-zinc-and-more

"**CORROSIVE WATER PROBLEMS**" by Swistock, Sharpe, and Robillard, at

extension.psu.edu/natural-resources/water/drinking-water/water-testing/pollutants/corrosive-water-problems

Observation

The most important indicator of corrosion is looking at pipes when they are repaired, and checking for above ground corrosion on valves, hydrants, etc.

Corrosion is most likely to be a problem in metal pipe—for example, iron—than in concrete or PVC pipes. However, metal fittings are present throughout most PWSs, so corrosion can cause problems there.

Whenever there is an opportunity, observations should be made to look for:

- Pitting;
- Pinholes;
- Plating or scaling;
- Tuberculation; and
- Any other signs of degradation.

Best practice is to keep track of problems and prioritize vulnerable areas for repair and/or replacement.

Critical corrosion water quality parameters

Alkalinity and **pH** are the most critical parameters when considering whether water is corrosive.

Other water quality parameters of interest may include:

- Inhibitor concentration, for example, silica or phosphate,
- Hardness,
- Sodium, chloride, sulfate, or other ions,
- Temperature,
- Disinfectant residual.

pH

The key water quality parameter for determining the likelihood that water will corrode pipes is the pH. The pH of water is easy to measure. If no other data is available, there may be data that is collected with the chemical samples.

pH is the related to the concentration of hydrogen ions in water as the log (base 10) of the hydrogen ion concentration:

$$pH = -\log_{10}[H^+]$$

Generally, moderate pH water is less corrosive. Acidic water is corrosive. Basic water may allow corrosion, while generally making water more 'plating.'

Recommended levels:

TCEQ minimum secondary contaminant level (SCL) of **7** pH units.
(TCEQ does not have a maximum SCL for basic water.)

The EPA's recommended range for pH is **6.5** to **8.5** pH units.

Alkalinity

Generally, moderate alkalinity water is less corrosive *and* less plating.

There are no regulatory limits for alkalinity.

- A general gauge for **low** alkalinity may be considered as < 60 mg/L as $CaCO_3$ (based on the EPA and TCEQ rules for total organic carbon removal in surface water, 30 TAC §290.112.
- A general level to consider **high** alkalinity can be considered to be >= 200 mg/L as $CaCO_3$.

Field measurement note

It is necessary to run carbon dioxide, pH and alkalinity determinations on-site, in the field, at the time of sample collection because these components will change rapidly on standing.

The presence of organic acids will be reported as alkalinity which will skew the index calculations by reporting too high a bicarbonate content.

Corrosion and scaling indices

None of the corrosion or scaling indices can be used as a 100% reliable predictor of water's tendency to corrode or scale pipes in every distribution system. A better estimate may be obtained by using the index developed under most similar conditions. Another way to gain insight into water quality is to calculate several indices and compare the results to see if they are all indicating similar corrosivity or scaling.

Nine indices are discussed below:

- Bayliss Curve,
- Langelier Saturation Index (LSI),
- Aggressive Index (AI),
- Ryznar Stability Index (RSI),
- Puckorious Scaling Index (PSI),
- Larson's Ratio (LR),
- Modified Larson's Ratio (MLR),
- Casil Index (CI), and
- Riddick Corrosion Index (RCI).

Scaling and corrosivity definitions

Scaling relates only to the tendency of sparingly soluble materials to precipitate on metallic surfaces.

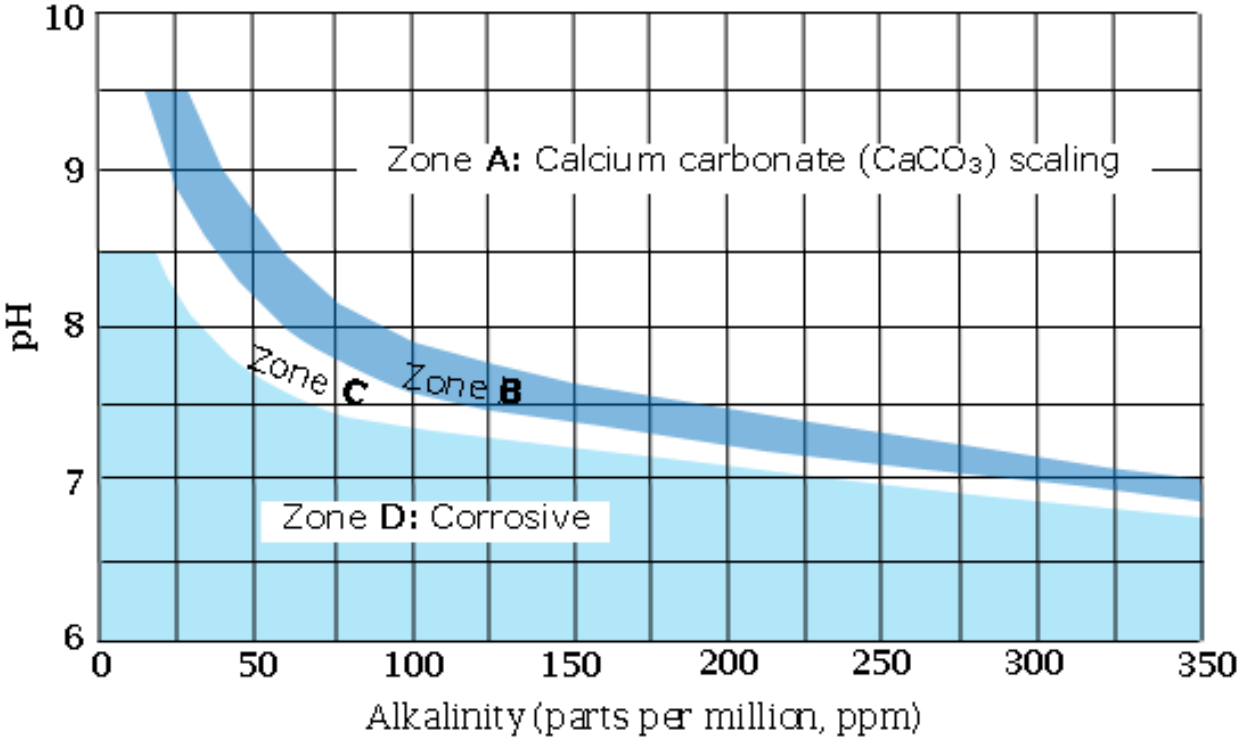
Corrosivity relates only to the tendency to support reactions that make up the corrosion process (anodic and cathodic).

Scaling and corrosivity are *not inversely related*. While there may be an informal link between the two conditions, there is no definitive, causal link. Therefore, some indices were developed to estimate *scaling*. Some estimate *corrosivity*.

Note:
None of the indices presented here are exact—they are estimates under the experimental conditions for which they were developed.

Bayliss Curve

The Bayliss Curve gives a rough idea of corrosivity or scaling potential. Although it is not very accurate, it is very useful because it is a graph, not a complex equation.



Legend:
Zone **A**: Zone of calcium carbonate deposition
Zone **B**: Calcium carbonate equilibrium
Zone **C**: Area for iron stain prevention
Zone **D**: Zone of serious corrosion

Disclaimer: *The Bayliss curve is an estimate only. The various chemicals present in natural water will impact the tendency of water to scale or corrode pipes. The Bayliss curve should be used in conjunction with other information, including observation of how pipes and appurtenances fail, calculated corrosion or scaling indices, and coupon tests. Additionally, the presence of current sources or dielelectrics will impact corrosivity.*

Although the Bayliss Curve has not been in wide use since the 1980s, its ease of use makes it a practical way to estimate the possibility that water may be corrosive.

Langelier Saturation Index (LSI)

The Langelier Saturation Indez (LSI) was developed based on two theoretical constructs:

- The rate of deposition of calcite deposition,
- The theory that deposition of calcium scale would protect metal from corrosion.

Since its inception, numerous studies have shown that the LSI **is not a reliable predictor of corrosion**, and it was never intended to be one. However, many drinking water professionals continue to use it. Reliance on the LSI alone is not advisable. Decisions should be based on empirical assessment and consideration of several indices, at a minimum.

The original, uncorrected form of LSI was calculated as follows

$LSI = pH - pH_S$

Where:

pH is the measured water pH

pH_S is the pH at saturation in calcite or calcium carbonate

pH_s also calculated with temperature and ionic strength corrections:

$pHs = (9.3 + A + B) - (C + D)$

where

pH_S = -log(K2'/KS') - log[Ca2+] - log[HCO3-]

A = (Log10[TDS in mg/L] − 1)/10

K2' = second disassociation constant for carbonic acid corrected for temperature and ionic strength

B = −13.12 × Log10(0C + 273) + 34.55

Ks' = solubility constant for CaCO3 corrected for temperature and ionic strength

C = Log10 [Ca2+ in mg/L as CaCO3] − 0.4

Where

[Ca2+] is in mol/L, [HCO3-] in mol/L

D = Log10 [alkalinity in mg/L as CaCO3]

LSI Range (*Note: LSI is less accurate under pH=6.5)*

If LSI is negative: No potential to scale, the water will dissolve CaCO3.

If LSI is positive: Scale can form and CaCO3 precipitation may occur.

If LSI is close to zero: Borderline scale potential.

Aggressive Index (AI)

The AI was theoretically formulated to determine the quality of water that can be transported through asbestos-cement pipe without adverse structural effects. It is a general indicator of the tendency for corrosion to occur in a specific water. It is one of the calcium carbonate saturation indexes, which include the LSI, RSI, PSI, and AI.

$$AI = pH + \log(AH) = pH + \log A + \log H$$

where:

A = total alkalinity as milligrams per liter of $CaCO_3$

H = calcium hardness as milligrams per liter of $CaCO_3$

AI range

Note: AI is less accurate under pH=6.5

AI < 10	Highly aggressive (corrosive) water
AI between 10 and 12	Moderately aggressive (corrosive) water
AI > 12	Non-aggressive (non-corrosive) water

References:

Source: EPA - Corrosion in Potable Water Systems, February 1982

Ryznar Stability Index (RSI)

The RSI was empirically developed to correlate an empirical database of scale thickness observed in municipal water systems to the water chemistry. Like the LSI, the RSI has its basis in the concept of saturation level. Ryznar attempted to quantify the relationship between calcium carbonate saturation state and scale formation.

The RSI is calculated as follows:

RSI = 2(pHS) - pH

Where:

pH is the measured water pH

pHS is the pH at saturation in calcite or calcium carbonate

pHS = p[Ca2+] + p[Alk] + A + B + C

p[Ca2+] = log10(100000/Calcium Hardness)

p[Alk] = log10(100000/Total Alkalinity)

A = 2.6045*exp(-0.0108 * Temperature in °C)

B = 0.0144*TDS^0.4545 TDS in mg/L

C = (1 + ((10^{-10.6} - pH)) * (1 + Temperature in °C/30)*2)

RSI range

Note: The RSI range is the same as the PSI range.

If the RSI value is below 6, calcium carbonate scaling is predicted, and above 6, the water will dissolve scale.

- RSI << 6 Scale forming (scale tendency increases as the index decreases)
- RSI 6 to 7 Neutral (non-scaling)
- RSI >> 8 Corrosive (mild steel corrosion becomes an increasing problem)

References:

corrosion-doctors.org/Cooling-Water-Towers/Index-Ryznar.htm

www.lenntech.com/calculators/ryznar/index/ryznar.htm (calculator)

www.kroff.com/Documents/Calculator_LangelierRyznar.xls (calculator)

Puckorius Scaling Index (PSI)

The PSI index is calculated in a manner similar to the RSI.

Developed for cooling tower scaling. Used for high Ca++ waters.

Water high in calcium, but low in alkalinity and buffering capacity can have a high calcite saturation level.

Puckorius uses an equilibrium pH rather than the actual system pH to account for the buffering effects:

PSI = 2 (pHs) - pHeq

Where:

pHs is the pH at saturation in calcite or calcium carbonate (see Ryznar)

pHeq = 1.465 x log10[Alkalinity] + 4.54

And:

[Alkalinity] = [HCO3-] + 2 * [CO32-] + [OH-]

PSI range

Note: The PSI range is the same as the RSI range.

As with RSI, if the PSI value is below 6, calcium carbonate scaling is predicted, and above 6, the water will dissolve scale.

- PSI << 6 Scale forming (scale tendency increases as the index decreases)
- PSI 6 to 7 Neutral (non-scaling)
- PSI >> 8 Corrosive (mild steel corrosion becomes an increasing problem)

References:

www.waterworld.com/articles/iww/print/volume-12/issue-6/feature-editorial/examining-scaling-indices-what-are-they.html

corrosion-doctors.org/Cooling-Water-Towers/Index-Puckorius.htm

Casil Index (CI)

The Casil Index is a modification to the calcium carbonate solubility indices that accounts for the effect of other parameters for soft waters.

$CI = Ca^{2+} + Mg^{2+} + HSiO_3$ - Anions/2

where:

each concentration is expressed in milliequivalents per liter

CI range

- CI < 0 = Very corrosive water
- CI between 0 and 0.1 Slightly corrosive water
- CI > 0.1 Non-corrosive water

References

Source: EPA - Corrosion in Potable Water Systems, February 1982

Larson's Ratio (LR)

Only a few parameters are needed to calculate LR. These constituents include chloride and sulfate. As a ratio, it compares the corrosion-enhancing properties of chloride and sulfate to the corrosion-inhibiting effect of alkalinity.

The LR was developed using experimental solutions containing bicarbonate, chloride, and sulfate ions, and is not designed to be applied to waters with low hardness and small concentrations of dissolved solids. It was observed that calcium in presence of alkalinity, regardless of pH or saturation index, is an effective inhibitor of corrosion. LR applies to cast iron and ductile iron.

The LR may be applicable to waters containing dissolved solids ranging from 250 to 1,000 mg/L (the range of dissolved solids in Larson's experimental solutions).

The LR equation is:

LR = ([Cl-] + 2 [SO42-]) / [HCO3]

where [ ] is expressed in moles per liter

LR range

- LR >0.5 Corrosive
- LR <0.5 Non-corrosive

Modified Larson's Ratio (LRM)

The LRM was empirically developed and piloted on various source waters and their blends. All waters were stablized to positive Langelier Index and chloraminated. The researchers piloted PVC, unlined iron, lined iron, and galvanized iron pipe. It is an iron corrosion index

The LRM cannot be used without alkalinity data

The LRM equation is:

LRM = ((Cl- + SO42- + Na+)1/2 / Alk) x (T/25) x (HRT)

Where:

Cl-	Chloride in mg/L
SO_4^{2-}	Sulfate in mg/L
Na^+	Sodium in mg/L
Alk	Total Alkalinity in mg/L as $CaCO_3$
T	Temperature (°C)
HRT -	Hydraulic Retention Time in days

To modify temperature units:

Temperature (°C x 9/5)+32

LRM Range:

- LRM >0.5 Corrosive
- LRM <0.5 Non-corrosive

References

Reference: Modified Larsons Ratio Incorporating Temperature, Water Age, and Electroneutrality Effects on Red Water Release, by S.A. Imran (National Research Council of Canada); J.D. Dietz, M.ASCE (UCF); G. Mutoti (Timmons Group); J.S. Taylor, M.ASCE (UCF); and A.A. Randall (UCF)

Riddick Corrosion Index (RCI)

RCI has been applied successfully to the typically soft ground waters of the eastern seaboard. Dissolved-oxygen (DO) concentration is a key component of the RCI calculations; another important measurement is barometric pressure, needed to calculate saturated dissolved oxygen.

$$RCI = 75/Alk * [CO_2 + 1/2*(Hardness - Alk) + Cl- + 2NO_3 *10/SiO_2*(DO+2)/(Sat DO)]$$

Riddick Corrosion Index also reported to be calculated as

$$RCI = 75/Alk * [CO_2 + 1/2 *(Hardness - Alk) + Cl^- + 2NO_3] *10/SiO_2*(DO +2)/(Sat DO)$$

where

CO_2	Carbon dioxide in mg/L
Alk	Alkalinity in mg/L as $CaCO_3$
Hardness	in mg/L as $CaCO_3$
Cl-	Chlorite ion in mg/L
NO_3	Nitrate in mg/L as nitrogen
SiO_2	Silica (silicon dioxide) in mg/L
DO	Dissolved oxygen in mg/L
Sat DO	Dissolved oxygen at saturation in mg/L

RCI range

- <5 Too non-corrosive
- between 6 and 25 Non-corrosive
- between 25 and 50 Corrosive (light)
- between 51 and 75 Corrosive (moderate)
- between 76 and 100 Corrosive
- >100 Very corrosive

References

pubs.usgs.gov/wri/1990/418

Appendix 7: Flushing

Flushing pipes is a critical, though boring and routine, action to keep distribution water clean and safe. If water sits in one place too long, it loses its disinfectant residual and bacteria can grow.

Scope

This appendix is intended to provide general guidance in revising or developing a dead-end main (DEM) flushing standard operating procedure (SOP).

Documents and data

PWSs are required to maintain records of monthly dead-end flushing.

PWSs are required to have a strategy to avoid having dead-ends in the system, for example by requiring developers to 'loop' lines.

More sophisticated PWSs will have SOPs and forms to maintain this data.

Resources

There are resources available to learn more about flushing.

EPA

"Effects of Water Age on Distribution System Water Quality"

www.epa.gov/sites/production/files/2015-09/documents/2007_05_18_disinfection_tcr_whitepaper_tcr_waterdistribution.pdf

AWWA

Distribution System Operations and the Impacts on Water Quality (Flushing Program) Module 7

www.hwea.org/wp-content/uploads/2015/07/Module-7-Final-AWWA-Workshop.pdf

AWWA Partnership for Safe Water: Distribution System Optimization Program

www.awwa.org/Portals/0/files/resources/water%20utility%20management/partnership%20safe%20water/files/Distribution%20Example%20SA%20Report.pdf

Flushing programs

Flushing is an important activity to keep lines clean and fresh—not stagnant.

Dead-end main (DEM) flushing

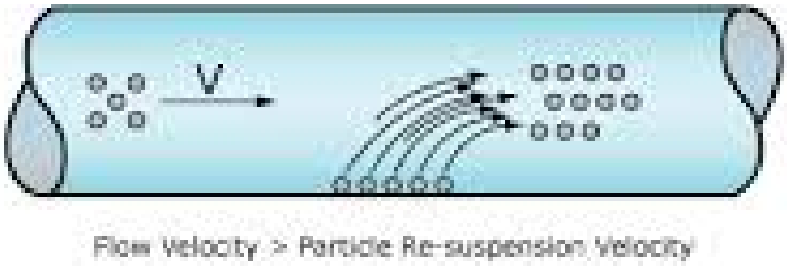
Most PWSs are familiar with the required monthly dead-end main (DEM) flushing. DEM flushing is intended to remove sediment and stagnant water. Generally, this is accomplished by slowly opening fire hydrants or flush valves at the end of mains.

DEMs may be large, but they also may be small, for example in non-looped cul de sacs. Depending on usage, DEMs may need more or less flushing.

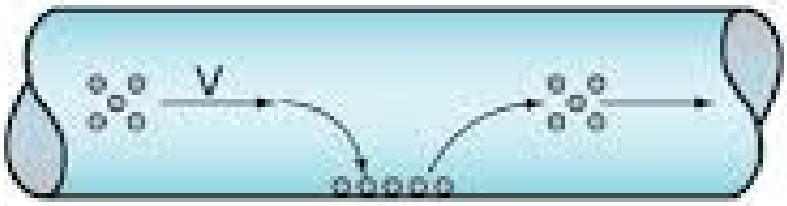
Best practice is to measure the disinfectant residual and ensure that a level over the minimum is achieved before ceasing to flush.

Unidirectional flushing (UDF)

Unidirectional flushing (UDF) is a way to flush any area of distribution to remove sediment. In order to remove settled material, the velocity of the water has to be fast enough to pick up the particles—as shown in the following figure. The velocity needed is over 5 feet per second (fps).

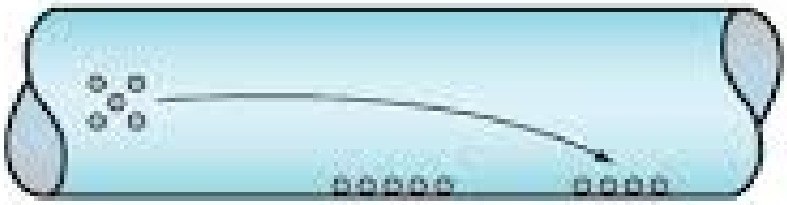


Flow Velocity > Particle Re-suspension Velocity



Particle Deposition Velocity < Flow Velocity ≤ Particle Re-suspension Velocity

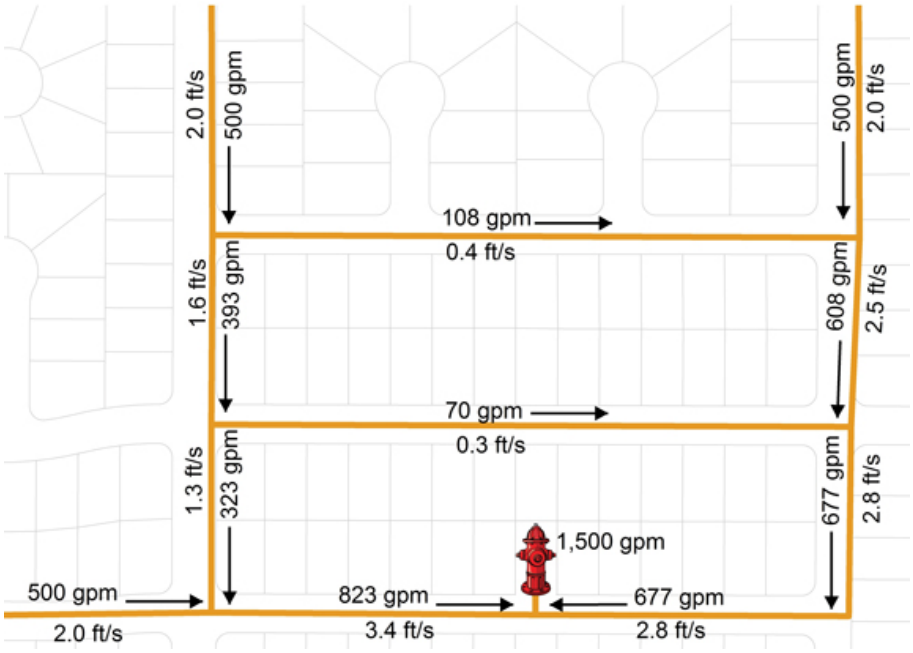
Settling of Particles Under Gravity and Into Pipe Wall Due to Particle/Pipe Surface Attractive Forces



Flow Velocity ≤ Particle Deposition Velocity :

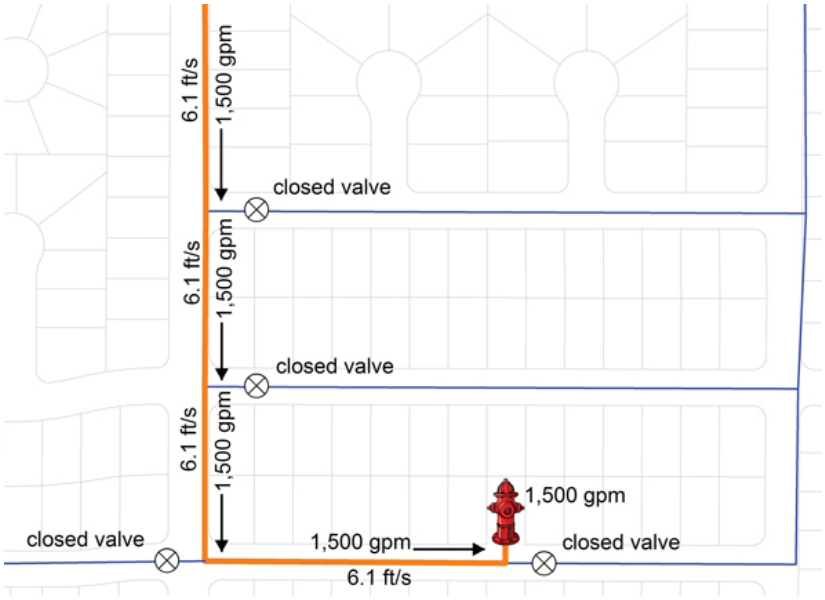
Settling and resuspension in distribution pipes

In order to achieve the velocity of 5 fps or more, the area to be flushed must be identified and managed to make the water flow 'unidirectionally.' In normal flushing, a hydrant is just opened, and water is allowed to flow through the entire area, as shown in the figure below.



Non-UDF flushing, where water is allowed to flow freely

When UDF is practiced, valves must be managed to force water into a pathway that makes it go faster than normal, as shown in the following figure.



UDF flushing, where water is forced to flow rapidly, in a single path

Clearly, the valves must be cycled so that each pipe gets the single flow, sequentially.

1. Purpose of Monthly DEM Flushing

The purpose of monthly DEM flushing is to remove stagnant water from pipes and reduce biological growth in the distribution system. Stagnant water in pipes allows bacterial regrowth and can allow the persistence of viruses and cysts. Stagnation in potable water can also cause taste, odor, and color problems.

Therefore, disinfectant residual monitoring is an integral part of the DEM flushing process. The TCEQ provides a regulatory guidance (RG) for 30 TAC §290.110 compliance monitoring: **RG 407: DISINFECTANT RESIDUAL REPORTING FOR PUBLIC WATER SYSTEMS**. That guide is available from the TCEQ's web site at:

www.tceq.texas.gov/publications/rg/rg-407.html

2. DEM Flushing SOP

By establishing a formal DEM Flushing SOP, the PWS can ensure that water used for flushing accomplishes its purpose without wasting water. A DEM Flushing SOP needs to describe:

- When each DEM is to be flushed;
- What water quality parameters will be measured and which levels trigger flushing of a DEM;
- How much water should be flushed from DEMs;
- How the data should be recorded and retained; and
- How to interpret the monitoring data to make the flushing process more efficient and prioritize the elimination of DEMs in Capital Improvement Plans through looping of pipes.

Like any SOP, the PWS's DEM Flushing SOP is a 'living' document. It should be reviewed and updated as the system changes.

2.1 Monitoring Frequency and Locations

A copy of the DEM Flushing SOP should be kept with the PWS's Monitoring Plan, required under 30 TAC §290.121, in order to ensure coordination between various sampling requirements.

DEM Monitoring Locations

The DEM Flushing SOP must include a list and map of all DEMs in the system. The TCEQ rules do not set any limit on pipe size for DEMs. The only exclusion in the TCEQ rules is found in 30 TAC §290.44(d)(6) and states that pipes less than 2-inch diameter that end in a customer service do not have to be equipped with a flush valve. All other DEMs must have a flush valve.

For many or most DEMs, a fire hydrant may be available for flushing. If not, it may be necessary to identify or add a mechanism to flush the DEMs where no hydrant is available.

The TCEQ's design rules in 30 TAC §290.44(d)(6) require that systems have a plan for minimizing DEMs as changes are made to the system. When the system makes changes to loop DEMs in order to eliminate them, the DEM Flushing SOP must be

updated. When expansion occurs, and additional DEMs are added, the DEM Flushing SOP must be updated to reflect these changes, too.

Frequency (related to trigger levels)

The rules require that every DEM be flushed monthly. In some cases, more frequent flushing may be needed to clear pipes of sediment or provide a disinfectant level. Less frequent sampling is a violation, unless approved by the TCEQ in a written response to a system's exception request.

2.2 Monitoring Parameters for Free and Total Chlorine

Analytical Methods

Any method approved by the EPA is acceptable for analysis. Most field test equipment for free chlorine and total chlorine use the DPD method, which is acceptable. The system should document their analytical methods in their Monitoring Plan. Examples are:

- Free chlorine – See 30 TAC §290.110(d)(1) , effective November 8, 2012

Although this guidance is for a PWS that uses free chlorine in the distribution system, the following information is provided for completeness:

- Total chlorine – See 30 TAC §290.110(d)(1), effective November 8, 2012
- Monochloramine – SM4500-Cl-D, -F, and -G
- Free ammonia - EPA 350.1 and SM 4500-NH3-G.
- Nitrite – EPA 300.0, 300.1 and SM 4110 B
- Nitrate - EPA 300.0, 300.1 and SM 4110 B

Free Chlorine

For a system that uses free chlorine, the primary monitoring parameter is the free chlorine residual. The other items that should be considered are taste, odor, sediment, and water color.

2.3 Documentation

In order to use the least water, while maintaining adequate disinfection, the PWS must document the amount of water used to flush. Additionally, in order to control the flushing volume, the PWS must record the disinfectant residual.

Operators should be instructed to collect flushing data on a data sheet, and all data sheets should be gathered and retained in a central location.

Table 1. Example of a DEM Flushing Data Sheet for When Using Free Chlorine as a Disinfectant

Year _____ **Month _____**	**PWS _____ _ (Target Free Chlorine = _____ mg/L)**						**Operator name _____**	
Location	**Start**			**Finish**				
	Date	Time	Residual (mg/L)	Date	Time	Flush Duration (mins.)	Residual (mg/L)	Volume of water flushed (gals.)

Volume of Water Flushed

In the examples above, the volume of water flushed at each site can be calculated by using estimated flow rates determined from a distribution system model and multiplied by the actual flushing duration. Another way is to attach a calibrated flow meter to the flush valves or fire hydrants. A system can use some other method for estimating water use, if desired.

3. Flushing Procedures

The DEM Flushing SOP needs to have detailed flushing instructions for operators to follow. These instructions and proper training of operators flushing DEMs will reduce the volume of water used for flushing DEMs.

Some recommended DEM flushing procedures for PWS staff:

- Select next DEM to be flushed from the PWS tracking database;
- Collect equipment necessary to flush the PWS:
  - Analytical equipment (ensure calibration);
  - Keys to lock(s);
  - Flush valve or fire hydrant valve wrenches;
  - Sample containers (for nitrite and nitrate);
  - Flow measuring device or distribution system model's estimated flow rate for the pipeline the DEM is located on and a watch;
  - Etc.
- Enter the location, DEM number, date and operator name;
- Open valve slowly and collect sufficient water to conduct water quality tests;
- Measure and record required water quality parameter levels listed on the PWS's DEM Flushing Data Sheet;

- If the measured water quality parameter levels:
    - **Meet** all trigger levels, then only flush the DEM until a chlorine residual level previously determined to achieve the increased flushing frequency (weekly, bi-monthly,) or the reduced flushing frequency (once every two months, once every three months) approved by the TCEQ is measured for the specific DEM;
    - Measure and record the volume of water flushed and the post-flush water quality levels;
  - OR
    - **Do not meet** one or more of the water quality parameters levels, then flush the DEM until all monitored water quality trigger levels are met and the total chlorine residual level previously determined to achieve the increased flushing frequency (weekly, bi-monthly) or reduced flushing frequency (once a month, once every three months) approved by the TCEQ is measured for the specific DEM;
    - Measure and record the volume of water flushed and the post flush water quality levels.
- <Other procedures determined by the PWS>.

Other considerations:

Care should be taken to avoid causing environmental or customer issues.

It is recommended that a diffuser be used when flushing through hydrants. The purpose of the diffuser is to keep the water from causing erosion. Additionally, some diffusers are able to add a chemical (such as sodium sulfite) to remove the chlorine or chloramine.

Precautions should be in place to avoid allowing water with a disinfectant residual to flow into lakes or streams. The disinfectant may kill fish, which is undesirable.

Water should not be flushed onto a homeowner's lawn without permission of the homeowner.

When flushing through a fire hydrant or larger flush valves, avoid water hammer. Operators should open the valve slowly to avoid water hammer. During the flushing procedure, open the valve completely at some point. This helps prevent debris from lodging in the hydrant valve seal when the hydrant is closed.

Unidirectional Flushing (UDF)

Unidirectional flushing (UDF) is a systematic method of flushing drinking water distribution piping by strategically closing valves and opening hydrants to direct water at high velocities through targeted segments of pipe.

The benefits to UDF include removing sediment and biological regrowth by flushing the distribution piping at a high enough velocity to re-suspend sediment in distribution pipes and scouring biofilm while using less water than conventional flushing.

Notes

Appendix 8: DAM 11 Training Evaluation Form

To be completed by trainees who participated in the DAM.

PWS Name: _____ Date: _____

Instructor Name: _____

Overall Evaluation:

① Strongly Agree ② Agree ③ No Opinion ④ Disagree ⑤ Strongly Disagree

1. The DAM agenda accurately described the training.	① ② ③ ④ ⑤
2. The technical level of the DAM was appropriate for the participants.	① ② ③ ④ ⑤
3. The schedule was reasonably timed.	① ② ③ ④ ⑤
4. The DAM covered the right amount of information.	① ② ③ ④ ⑤
5. The handouts were understandable and helpful.	① ② ③ ④ ⑤
6. The presentation helped my understanding.	① ② ③ ④ ⑤
7. The graphics in this DAM helped me understand the subjects covered.	① ② ③ ④ ⑤
8. Workshop 1 adequately explained the scope and procedure for a Level 1 Assessment.	① ② ③ ④ ⑤
9. Workshop 2 adequately explained Section 1—how to assess coliform sites and sampling.	① ② ③ ④ ⑤
10. Workshop 3 adequately explained Sections 2—assessing the coliform SOP.	① ② ③ ④ ⑤
11. Workshop 4 adequately explained Section 3—assessing the distribution system design, maintenance, operation, nitrification, and backflow prevention.	① ② ③ ④ ⑤
12. Workshop 5 adequately explained Sections 4—assessing tanks.	① ② ③ ④ ⑤
13. Workshop 6 adequately explained Section 5—assessing sources.	① ② ③ ④ ⑤
14. Workshop 7 adequately explained Section 6—assessing treatment.	① ② ③ ④ ⑤
15. Workshop 8 adequately explained Section 7 and 8—assessing the impact of security breaches and extreme weather.	① ② ③ ④ ⑤
16. Workshop 8 adequately explained Section 9, 10, and 11—Corrective Action Report and Plan (CARP), sanitary defects, additional issues, and signature.	① ② ③ ④ ⑤
17. After this training, it will be easier to perform a Level 1 Assessment.	① ② ③ ④ ⑤
18. The DAM was exactly what we needed.	① ② ③ ④ ⑤

PWS Name: _____ Date: _____

Specific Suggestions:

What could we change to improve this Directed Assistance Module?

What did we not explain well enough for you to understand?

What areas did we spend too much time on?

What areas did we spend too little time on?

What are some other issues where you feel more training is needed?

What other comments or suggestions do you have?

Appendix 9a: DAM 11 Pre-Test

Instructions: The Pre- and Post-Tests are intended to help you evaluate your learning. All staff who participate in this training event should complete this Pre-Test. Answer all questions to the best of your ability. After the Post-Test is done, the Instructor will go over the correct answers.

Training location: _____ Date: _____

Student name or code _____

If you choose to remain anonymous, please enter a code or nickname so that the instructor can match the pre- and post-test results to help evaluate the effectiveness of the training.

Position—check all that apply

○ Operator ○ Student ○ Administrator ○ Assistance provider
○ Engineer ○ Consultant ○ Regulator ○ Other _____

Pre-test: Mark ALL answers that apply

1. The presence of total coliform in drinking water indicates that:
   - ① A potential risk to public health is present.
   - ② The source water is contaminated.
   - ③ A security breach has occurred.
   - ④ Bacteria are present in distribution pipes or sample lines.
   - ⑤ A boil-water notice should be issued.
2. An SOP for coliform collection:
   - ① Should be used by sample collectors.
   - ② Should not be followed by experienced staff.
   - ③ Should be provided to new staff.
   - ④ Should require that samples be collected regardless of weather.
3. Coliform sample locations
   - ① Must be at hydrants.
   - ② Must be representative of the entire distribution system.
   - ③ Must be rotated.
   - ④ May be at inactive service connections.
4. How frequently should coliform samples be collected?
   - ① As often as the PWS chooses to sample.
   - ② Early in the month.
   - ③ At regular intervals.

5. What are the required setbacks for wells?

   ① 150 feet from livestock in pastures.
   ② 500 feet from animal feed lots.
   ③ 300 feet from a sewage wet well.
   ④ 150 feet from a drainage ditch containing industrial waste discharges.
   ⑤ 50 feet from lands on which sewage plant or septic tank sludge is applied.

6. What is the purpose of maintaining a disinfectant residual in the distribution system?

   ① To keep the chemical vendors happy.
   ② To kill or sterilize (inactivate) pathogens.
   ③ To cause beneficial nitrification.
   ④ To track water age in the distribution system.

7. A pathogen is….

   ① An unimproved gravel road to someone named Jen.
   ② Any bacteria.
   ③ A microorganism that can cause disease.
   ④ Fatal.

8. A cross connection control program…

   ① Is the final barrier to pathogens in drinking water.
   ② Only applies to community PWSs.
   ③ Does not include Customer Service Inspections.
   ④ Must be implemented by the local fire department.

9. Possible hazards needing backflow protection include:

   ① Mortuaries
   ② Septic fields near irrigation systems
   ③ Hospitals
   ④ Veterinarian offices
   ⑤ Distilleries

10. Allowing cattle to graze over a PWS well:

    ① Protects the cattle from dehydration.
    ② Is a bad idea.
    ③ Is appropriate only if cattle are properly diapered in accordance with AWWA standards.
    ④ Is a violation of TCEQ regulations.

11. Water age is considered during a Level 1 Assessment because:

① Excessive water age can cause stagnation.
② Water age greater than two days is a sanitary defect.
③ Water age is unknown in drinking water distribution systems.
④ Disinfectant decay is a function of water age.

12. How can storage be optimized to reduce water age?

① Set the operating tank level as high as possible.
② Do not install mixing devices.
③ Locate inlet and outlet directly across from each other.
④ Deep cycle tanks.

13. What type of bottles are used for coliform sample collection?

① Any clean bottle is acceptable.
② Bottles must be provided by the laboratory performing analysis.
③ Amber glass bottles with septa tops must be used.
④ A sanitary 50-mL plastic bottle is used.

14. What action(s) should a PWS take when a total coliform is found in a routine sample?

① Leave town with no forwarding address.
② Wait two weeks, then call the lab to discuss whether they made a mistake.
③ Call TCEQ.
④ Notify the customers to boil their water.
⑤ Take repeats.

15. Are repeat coliform samples important?

① No—adequate information is gathered through routine monitoring.
② Yes—it helps determine the severity of an issue.
③ No—repeat sampling is recommended but not required by rule.

16. When the disinfectant residual is low:

① Nitrification is definitely occurring.
② A backflow or cross connection event is definitely occurring.
③ The chlorinator definitely failed.
④ Verification samples should be collected.
⑤ The PWS should find out why and fix it.

17. A PWS should contact TCEQ:

    ① If a coliform sample is positive.
    ② If the water rates are too high.
    ③ To request free, on-site assistance from the FMT program.
    ④ Never.

18. When must a PWS issue a BWN?

    ① When a low pressure complaint is received.
    ② When distribution samples are total coliform positive (TC+).
    ③ For pressure less than 35 psi.
    ④ When TCEQ requires that a BWN be issued.
    ⑤ When there is an *E. coli* MCL.

19. Can drought cause a degradation in water quality?

    ① No—drought could degrade water quantity but not quality.
    ② Yes—By making it so a lower-quality source must be used.
    ③ Yes—Because the water will be too dry.
    ④ Yes—By increasing leaks in areas with 'gumbo' soils.

20. A 'sanitary defect' is:

    ① A potential pathway to pathogens.
    ② Any violation of TCEQ rules.
    ③ Wearing dirty socks.
    ④ A thing that needs to be corrected.

Appendix 9b: DAM 11 Post-Test

Instructions: The Pre- and Post-Tests are intended to help you evaluate your learning. All staff who participate in this training event should complete this Pre-Test. Answer all questions to the best of your ability. After the Post-Test is done, the Instructor will go over the correct answers.

Training location: _____ Date: _____

Student name or code _____

If you choose to remain anonymous, please enter a code or nickname so that the instructor can match the pre- and post-test results to help evaluate the effectiveness of the training.

Position—check all that apply

○ Operator ○ Student ○ Administrator ○ Assistance provider
○ Engineer ○ Consultant ○ Regulator ○ Other _____

Pre-test: Mark ALL answers that apply

1. The presence of total coliform in drinking water indicates that:
   - ① A potential risk to public health is present.
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2. An SOP for coliform collection:
   - ① Should be used by sample collectors.
   - ② Should not be followed by experienced staff.
   - ③ Should be provided to new staff.
   - ④ Should require that samples be collected regardless of weather.
3. Coliform sample locations
   - ① Must be at hydrants.
   - ② Must be representative of the entire distribution system.
   - ③ Must be rotated.
   - ④ May be at inactive service connections.
4. How frequently should coliform samples be collected?
   - ① As often as the PWS chooses to sample.
   - ② Early in the month.
   - ③ At regular intervals.

5. What are the required setbacks for wells?

   ① 150 feet from livestock in pastures.
   ② 500 feet from animal feed lots.
   ③ 300 feet from a sewage wet well.
   ④ 150 feet from a drainage ditch containing industrial waste discharges.
   ⑤ 50 feet from lands on which sewage plant or septic tank sludge is applied.

6. What is the purpose of maintaining a disinfectant residual in the distribution system?

   ① To keep the chemical vendors happy.
   ② To kill or sterilize (inactivate) pathogens.
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   ④ To track water age in the distribution system.

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    ④ Never.

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    ⑤ When there is an *E. coli* MCL.

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    ③ Yes—Because the water will be too dry.
    ④ Yes—By increasing leaks in areas with 'gumbo' soils.

20. A 'sanitary defect' is:

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    ② Any violation of TCEQ rules.
    ③ Wearing dirty socks.
    ④ A thing that needs to be corrected.

Appendix 10: Level 1 Assessment WORK SHEET

Public Water System (PWS) Information	
PWS Name:	PWS ID:
Assessment Trigger Date:	Completion Date:

Reason for triggering L1A	
1. For a PWS which collects 40 or more distribution samples per month, the treatment technique trigger is defined as when more than 5.0% of samples collected in a month are total coliform-positive.	☐
2. For a PWS which collects fewer than 40 distribution samples per month, the treatment technique trigger is defined as when two or more samples collected in a month are total coliform-positive.	☐
3. The PWS failed to collect all required repeat samples after a total coliform-positive result.	☐
Please note that No. 1 and 2 below are required attachments. **Required Attachments**	**Attached?**
1. Coliform sample collection Standard Operating Procedure (SOP).	☐
2. One month of disinfection residual data prior to the trigger date.	☐
Supporting documentation	
3. Attach any additional documentation pertinent to the assessment event.	☐
Supporting documentation may include:	**Needed?**
Latest **CCI report**, including documentation of any items that were required to be corrected based on that investigation	
Other TCEQ **regulatory correspondence** —for example letters, notices of violation, Corrective Action Plans, or self-audits for PWS activities	
Completed **Microbial Submission Report** chain-of-custody forms for TC+ and rejected samples	
Monitoring plan, including	
• The coliform **Sample Siting Plan** (SSP)	
• The **distribution system map**	
• Distribution operation and maintenance records	
Flushing records from the recent months	
Additional disinfection level results for the month before triggering the assessment, and all of the data collected for the trigger month—a required attachment	
SOP for **disinfection after repair**	

and/or construction	
Pressure data and **complaint** records, if available	
Water loss data, to determine how leaky the system is	
If chloramines are present, the Nitrification Action Plan (**NAP**) and recent **chloramine-effectiveness** sampling data	
Cross-connection control program documents, for example **Service Agreements** and/or **Customer Service Inspection** reports and/or Backflow Prevention Assembly **Testing and Maintenance** (T&M) forms	
Tank inspection reports and tank maintenance records, if present	
Chemical and water usage reports, if needed to evaluate whether disinfectant is dosed correctly	
If the PWS operates a SWTP, the **SWMORs** for the two months prior to the month the trigger occurred, and all data collected for the trigger month.	
Sanitary Control Easements or Exceptions	
Other supporting documentation, describe:	

Section 1—List TC+ Sites

If there are multiple TC+, it may help the assessor to list them.

Site # on list	Address (or location description)	Dates of TC+ or rejects	Sanitary issues?	In SSP?	In CARP ?
Site 1					
Site 2					
Site 3					
Site 4					
Site 5					
Site 6					
Site 7					
Site 8					
Site 9					
Site 10					

(Add additional lines if needed.)

First TC+ Site Assessed (Site 1)

❖**Address of first sample site:** _____

Section 1 —**First** TC+ Coliform Sample Site Assessed	Yes	No	N/A	In CARP ?
1. Does **this** sample tap(s) have a Point of Use (POU) treatment device installed? (If unknown, contact customer and ask.)	☐	☐		
2. Was it determined that any plumbing repairs and/or additions were made at **this** sampling site? ❖**If so, describe:**	☐	☐		
3. Is **this** sampling tap or site unsanitary? Sample tap and area around the sample tap should be: • Clean and dry; ❑ • Free of animal droppings; ❑ • Located adequate distance from spray irrigation systems or other contaminants; and ❑ • Free of excessive vegetation or other impediments to sample collection, etc. ❑	☐	☐		
4. Is the height of **this** sample tap • Above grade and ❑ • Not positioned close to the ground? ❑	☐	☐		
5. Is **this** sample tap subject to flooding and/or excessive surface runoff?	☐	☐		
6. Does **this** sampling tap have a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator? ❖**If so, describe:**	☐	☐		
7. Is the sample tap located on or near a dead end main? ❖**If so, how far?**	☐	☐		
8. Is **this** sample tap (faucet) located on an interior location that is used for other activities? (i.e., kitchen, janitorial, or commercial sinks, etc.) ❖**If so, describe:**	☐	☐		
9. Is **this** sample tap • in good condition and ❑ • free of leaks around the stem or packing? ❑	☐	☐		
10. Can **this** sample tap be adjusted to obtain an even low-flow of water without excessive splash during sample collection? ❖**If not, describe:**	☐	☐		

Action Items:

Second TC+ Site Assessed (Site 2)

❖**Address of second sample site:** _____

Section 1 —**Second** TC+ Coliform Sample Site Assessed	Yes	No	N/A	In CARP ?
1. Does **this** sample tap(s) have a Point of Use (POU) treatment device installed? (If unknown, contact customer and ask.)	☐	☐		
2. Was it determined that any plumbing repairs and/or additions were made at **this** sampling site? ❖**If so, describe:**	☐	☐		
3. Is **this** sampling tap or site unsanitary? Sample tap and area around the sample tap should be: • Clean and dry; ❑ • Free of animal droppings; ❑ • Located adequate distance from spray irrigation systems or other contaminants; and ❑ • Free of excessive vegetation or other impediments to sample collection, etc. ❑	☐	☐		
4. Is the height of **this** sample tap • Above grade and ❑ • Not positioned close to the ground? ❑	☐	☐		
5. Is **this** sample tap subject to flooding and/or excessive surface runoff?	☐	☐		
6. Does **this** sampling tap have a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator? ❖**If so, describe:**	☐	☐		
7. Is the sample tap located on or near a dead end main? ❖**If so, how far?**	☐	☐		
8. Is **this** sample tap (faucet) located on an interior location that is used for other activities? (i.e., kitchen, janitorial, or commercial sinks, etc.) ❖**If so, describe:**	☐	☐		
9. Is **this** sample tap • in good condition and ❑ • free of leaks around the stem or packing? ❑	☐	☐		
10. Can **this** sample tap be adjusted to obtain an even low-flow of water without excessive splash during sample collection? ❖**If not, describe:**	☐	☐		

Action Items:

Third TC+ Site Assessed (Site 3)

❖**Address of third sample site:** _____

Section 1 —**Third** TC+ Coliform Sample Site Assessed	Yes	No	N/A	In CARP ?
1. Does **this** sample tap(s) have a Point of Use (POU) treatment device installed? (If unknown, contact customer and ask.)	☐	☐		
2. Was it determined that any plumbing repairs and/or additions were made at **this** sampling site? ❖**If so, describe:**	☐	☐		
3. Is **this** sampling tap or site unsanitary? Sample tap and area around the sample tap should be: • Clean and dry; ❑ • Free of animal droppings; ❑ • Located adequate distance from spray irrigation systems or other contaminants; and ❑ • Free of excessive vegetation or other impediments to sample collection, etc. ❑	☐	☐		
4. Is the height of **this** sample tap • Above grade and ❑ • Not positioned close to the ground? ❑	☐	☐		
5. Is **this** sample tap subject to flooding and/or excessive surface runoff?	☐	☐		
6. Does **this** sampling tap have a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator? ❖**If so, describe:**	☐	☐		
7. Is the sample tap located on or near a dead end main? ❖**If so, how far?**	☐	☐		
8. Is **this** sample tap (faucet) located on an interior location that is used for other activities? (i.e., kitchen, janitorial, or commercial sinks, etc.) ❖**If so, describe:**	☐	☐		
9. Is **this** sample tap • in good condition and ❑ • free of leaks around the stem or packing? ❑	☐	☐		
10. Can **this** sample tap be adjusted to obtain an even low-flow of water without excessive splash during sample collection? ❖**If not, describe:**	☐	☐		

Action Items:

Fourth TC+ Site Assessed (Site 4)

❖**Address of fourth sample site:** _____

Section 1 —**Fourth** TC+ Coliform Sample Site Assessed	Yes	No	N/A	In CARP ?
1. Does **this** sample tap(s) have a Point of Use (POU) treatment device installed? (If unknown, contact customer and ask.)	☐	☐		
2. Was it determined that any plumbing repairs and/or additions were made at **this** sampling site? ❖**If so, describe:**	☐	☐		
3. Is **this** sampling tap or site unsanitary? Sample tap and area around the sample tap should be: • Clean and dry; ❑ • Free of animal droppings; ❑ • Located adequate distance from spray irrigation systems or other contaminants; and ❑ • Free of excessive vegetation or other impediments to sample collection, etc. ❑	☐	☐		
4. Is the height of **this** sample tap • Above grade and ❑ • Not positioned close to the ground? ❑	☐	☐		
5. Is **this** sample tap subject to flooding and/or excessive surface runoff?	☐	☐		
6. Does **this** sampling tap have a swivel-type faucet or similar "Y" type attachment/connection, or equipped with an aerator? ❖**If so, describe:**	☐	☐		
7. Is the sample tap located on or near a dead end main? ❖**If so, how far?**	☐	☐		
8. Is **this** sample tap (faucet) located on an interior location that is used for other activities? (i.e., kitchen, janitorial, or commercial sinks, etc.) ❖**If so, describe:**	☐	☐		
9. Is **this** sample tap • in good condition and ❑ • free of leaks around the stem or packing? ❑	☐	☐		
10. Can **this** sample tap be adjusted to obtain an even low-flow of water without excessive splash during sample collection? ❖**If not, describe:**	☐	☐		

Action Items:

Section 2—Coliform Sampling Protocol and Sample Collection	**Yes**	**No**	**N/A**	**In CARP ?**
1. Were all samples collected according to a sample collection Standard Operating Procedure (SOP)? (e.g., SOP should include, at a minimum, tap sterilization, flushing, aerator removal, and the use of sterile bottles, etc.) ❖ **If so, describe:**	☐	☐		
2. Were all samples collected according to the Sample Siting Plan (SSP)? ❖ **If not, why not?**	☐	☐		
SOP Elements				
3. Were any attachments on the faucet removed?	☐	☐		
4. Was the sample tap flushed for approximately 5 minutes and until a residual disinfectant concentration of at least 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) was present in the water prior to sample collection?	☐	☐		
5. Was the sample tap treated in preparation for sample collection? (i.e., swabbed or sprayed with disinfectant, or flamed, etc.)	☐	☐		
6. Did the collector ensure that the sample was collected from a cold water tap instead of a hot water tap?	☐	☐		
7. Was a sterile laboratory-provided total coliform (TC) sample bottle used and was the sample bottle handled appropriately? (i.e., sample bottle was not exposed to contamination on the inside or its cap, etc.)	☐	☐		
8. Did the collector ensure that the sample bottle was not rinsed prior to sample collection or overfilled during sample collection?	☐	☐		
9. Were the samples delivered in a cooler not subject to contamination from other sources? (i.e., drinking water and wastewater samples should not be delivered in the same cooler, etc.)	☐	☐		
10. Were samples delivered to the laboratory within the allowable holding time?	☐	☐		
11. Were any laboratory analytical issues found?	☐	☐		

Action Items:

Section 3—Distribution System	Yes	No	N/A	In CARP ?
1. Are all pumps, valves, and meters maintained and operational? ❖ **If not, describe:**	☐	☐		
2. Was there construction near the positive sample site either upstream or downstream? ❖ **If so, describe:**	☐	☐		
3. Were any line leaks repaired and disinfected in accordance with American Water Works Association (AWWA) standards? ❖ **If so, describe:**	☐	☐	☐	
4. Were there any live leaks in the distribution system during sample collection? ❖ **If so, describe:**	☐	☐		
5. Was there an unusual water demand around the time of the positive samples? (i.e., recent fire hydrant or valve usage, line break event, etc.) ❖ **If so, describe:**	☐	☐		
6. Were there any residual disinfectant concentrations below 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) present in the affected area(s) or in any part of the distribution system? ❖ **If so, describe:**	☐	☐		
7. Did the pressure drop below 20 psi anywhere in the distribution system? ❖ **If so, describe:**	☐	☐		
8. Were required "Special Precautions" (Figure: 30 TAC §290.47(e)) procedures followed if the pressure dropped below 20 psi anywhere in the distribution system? (see instructions) ❖ **If so, describe:**	☐	☐	☐	
9. If there are any air release devices in the affected area(s), are they installed in such a manner as to preclude the possibility of submergence or possible entrance of contaminants? ❖ **If not, describe:**	☐	☐	☐	
10. Is the distribution system designed to afford effective circulation of water in the affected area(s) with a minimum of dead ends? ❖ **If not, describe:**	☐	☐		
11. Are water distribution lines constructed and located to protect against contamination from wastewater mains and/or laterals?	☐	☐		
12. Are all dead-end mains flushed at monthly intervals and dead-end lines and other mains in the affected area(s) flushed as needed? ❖ **If not, describe:**	☐	☐	☐	

Action Items:

Section 3—Distribution System, continued Nitrification	**Yes**	**No**	**N/A**	**In CARP ?**
13. If it was determined that nitrification occurred recently in the affected area(s) of the distribution system, did the PWS implement provisions of its Nitrification Action Plan (NAP) in the affected area(s) of the distribution system? ❖ **If so, describe:**	☐	☐	☐	
14. Was the PWS performing a temporary conversion to free chlorine in the affected area(s) of the distribution system during the time the total coliform-positive sample(s) was/were collected? ❖ **If so, describe:**	☐	☐	☐	

Action Items:

Section 3—Distribution System, continued Cross-connection control and backflow prevention	**Yes**	**No**	**N/A**	**In CARP ?**
15. Were all backflow prevention assemblies tested and determined to be functioning at the positive sample site, as applicable? ❖**If not, why not?**	☐	☐	☐	
16. Was it determined that the distribution water was impacted by any other backflow-event? ❖**If so, what happened?:**	☐	☐		
17. Are appropriate backflow prevention assemblies and/or air gap installed at every connection with a potential health hazard, and tested and determined to be functioning, as applicable? ❖**If so, what happened?:**	☐	☐	☐	

Action Items:

Section 4—List Tanks

If there are multiple tanks, it may help the assessor to list them.

Tank # on list	**Address (or location)**	**Tank type (eg Elevated, bladder, etc)**	**Onsite visit date**	**Last inspection date**		**Sanitary issues?**	**In CARP ?**
Tank 1							
Tank 2							
Tank 3							
Tank 4							
Tank 5							
Tank 6							
Tank 7							
Tank 8							
Tank 9							
Tank 10							

(Add additional lines if needed.)

Action Items:

Section 4—Water Storage and Pressure Tanks	Yes	No	N/A	In CARP ?
1. Are all pressure and storage tanks maintained and operational? ❖**If not, which tank(s):**	☐	☐	☐	
2. Have all storage tanks been inspected in the past year? ❖**If not, which tank(s):**	☐	☐	☐	
3. Have all pressure tank exteriors been inspected in the past year? ❖**If not, which tank(s):**	☐	☐	☐	
4. Have all pressure tanks with inspection ports had an interior inspection in the past five years? ❖**If not, which tank(s):**	☐	☐	☐	
5. Have all issues found during tank inspections been addressed? ❖**If not, which tank(s):**	☐	☐	☐	
6. Are all tank openings and roof vents screened with **16-mesh or finer screen**? ❖**If not, which tank(s):**	☐	☐	☐	
7. Are **all** tank **overflows fitted with a cover** that closes automatically and has no gap over 1/16 inch? ❖**If not, which tank(s):**	☐	☐	☐	
8. Is the PWS managing water turnover in **ALL** finished water storage tanks to account for low water use to minimize and/or prevent excessive water age, as applicable? ❖**If not, which tank(s):**	☐	☐	☐	
9. Does **any** tank have excessive sediment? ❖**If not, which tank(s):**	☐	☐	☐	
10. Are **ALL** clearwells, standpipes, ground storage, elevated tanks, and below ground storage tanks properly **located away from hazards**? (i.e., hazards such as: municipal or industrial sewage treatment plant; land which is spray irrigated with treated sewage effluent and/or sludge disposal; under buildings, sanitary sewer, septic tank and/or septic tank soil absorption system, etc.) ❖**If not, which tank(s):**	☐	☐	☐	
11. Are all potable water storage tanks (including pressure tanks) thoroughly **tight against leakage** and were any applicable **hatches locked**? ❖**If not, which tank(s):**	☐	☐	☐	
12. Were there any residual disinfectant concentrations **below** 0.2 mg/L free chlorine residual or 0.5 mg/L chloramine residual (measured as total chlorine) present in **any** finished water storage tank, as applicable? ❖**If not, which tank(s):**	☐	☐	☐	

Action items:

Section 5—List Sources

If there are multiple sources, it may help the assessor to list them.

Source # on list	**Address (or location description)**	**Type**	**Sanitary issues?**	**Dates of on-site review**	**In CARP ?**
Source 1					
Source 2					
Source 3					
Source 4					
Source 5					
Source 6					
Source 7					
Source 8					
Source 9					
Source 10					

(Add additional lines if needed.)

Section 5—Wells If the PWS does not have wells, check here and skip this section: (wells include groundwater under the direct influence of surface water (GUI))	**Yes**	**No**	**N/A**	GW? Y / N **In CARP ?**
1. Does the PWS control and protect land within 150 feet of each well? ❖**If not, which well(s):**	☐	☐		
2. Does every well have a sanitary control easement (SCE) or SCE exception? ❖**If not, which well(s):**	☐	☐	☐	
3. Are there known hazards within 50 - 500 feet of any well, as applicable? (i.e., hazards such as: septic system and related appurtenances; livestock; etc.) ❖**If not, which well(s):**	☐	☐		
4. Is the wellhead and pump base constructed and sealed properly to minimize contamination? ❖**If not, which well(s):**	☐	☐		
5. Are all well casing vents and applicable air release devices covered with 16-mesh or finer screen? ❖**If not, which well(s):**	☐	☐		
6. Are all well blow-off lines (if provided) constructed so that the discharge will not be submerged by flood waters? ❖**If not, which well(s):**	☐	☐	☐	
7. Has an unusual raw water contamination incident or flooding incident occurred at the well site? ❖**If not, which well(s):**	☐	☐		

Section 5—Purchased water— If the PWS does not purchase water skip this section:	**Yes**	**No**	**N/A**	PW? Y / N **In CARP ?**
1. Are all the entry point meters, vaults, and sample taps sanitary? ❖**If not, which source(s):**	☐	☐		
2. Is the water supplier experiencing issues with coliform bacteria? ❖**If not, which source(s):**	☐	☐		

Section 5—Surface water intakes If the PWS does not use surface water, skip this section:	**Yes**	**No**	**N/A**	SW? Y / N **In CARP ?**
1. Is every surface water intake functional and operated correctly? ❖**If not, which intake(s):**	☐	☐		
2. Has an unusual raw water contamination incident occurred at the intake site? ❖**If not, which intake(s):**	☐	☐		

Action items:

Section 6—Treatment	Yes	No	N/A	In CARP ?
1. Have there been any interruptions and/or changes in treatment? ❖**If not, which plant(s): How long?**	☐	☐	☐	
2. Are all treatment processes correctly maintained and operational? ❖**If not, which plant (s):**	☐	☐	☐	
3. Have all surface water treatment plants (SWTP) and GUI wells met all approved concentration time (CT) and turbidity requirements, as applicable? ❖**If not, which plant (s):**	☐	☐	☐	
4. Is all groundwater disinfected prior to distribution, and disinfection provided ahead of the water storage tank(s) if storage is provided prior to distribution? ❖**If not, which plant (s):**	☐	☐	☐	
5. Have all wells met all 4-log inactivation requirements, as applicable? ❖**If not, which plant (s):**	☐	☐	☐	

Section 7—Security and Extreme Weather Event	Yes	No	N/A	In CARP ?
1. Were all water treatment plants and all appurtenances, raw water pump stations, water storage tanks, and wells enclosed by an intruder-resistant fence or enclosed in a lockable building, as applicable? ❖**If not, what happened?**	☐	☐	☐	
2. Did any security breaches or vandalism occur in the PWS near the time of the total coliform-positive (TC+) sample? ❖**If so, what happened?**	☐	☐		
3. Did any extreme weather occur around the time of the positive samples? ❖**If so, what happened?**	☐	☐		

Required Additional Information and Attachments

Section 8—Outstanding Notice of Violations (NOV) and/or Enforcement Actions	Yes	No	In CARP ?
1. Is the PWS under some other Compliance Schedule for anything related to the event that triggered the assessment?	☐	☐	
If yes, describe:			

Action items:

Required Additional Information and Attachments

Section 8 – Outstanding Notice of Violations (NOV) and/or Enforcement Actions	**Yes**	**No**
1. Is the PWS under some other Compliance Schedule for anything related to the event that triggered the assessment?	☐	☐
If yes, describe:		

Please note that No. 1 and 2 below are required attachments.	**Attached**
1. Coliform sample collection Standard Operating Procedure (SOP), as referenced in Section 2.	☐
2. One month of disinfection residual data prior to the assessment trigger date.	☐
3. **(Optional)** Attach any additional documentation pertinent to the assessment event.	☐
Describe:	

Section 9 – Sanitary Defects (SD) and Corrective Actions (CA)		
Did the PWS identify any Sanitary Defects in Section 1 – 7 of the assessment form?	**Yes** ☐	**No** ☐

Section No.	**Sanitary Defect (SD) and associated Corrective Action (CA)**				
SD					
CA					
	CA Completed?	**Yes** ☐	**No** ☐	If "No", please indicate Proposed Compliance Deadline	

Section No.	**Sanitary Defect (SD) and associated Corrective Action (CA)**				
SD					
CA					
	CA Completed?	**Yes** ☐	**No** ☐	If "No", please indicate Proposed Compliance Deadline	

Revision table:

Date	Action	Comments
May 3, 2016	Created	
May 17, 2016	Revised, Version 1	Reorganized based on QC
July 4, 2017	Revised, Version 2	Incorporate L1A Form changes
March 1, 2018	Revised, Version 2	Formatting
February 21, 2019	Revised, Version 2	Formatted for accessibility

Thanks for your participation!