Revised Total Coliform Rule Assessments and Corrective Actions Guidance Manual

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DISCLAIMER

This manual is intended to provide information to assist public water systems in complying with the Level 1 and Level 2 assessment and corrective action requirements under the Revised Total Coliform Rule (RTCR).

This guidance is not a substitute for applicable legal requirements, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on any party, including EPA, States or the regulated community. While EPA has made every effort to ensure the accuracy of the discussion in this guidance, the obligations of the regulated community are determined by statutes, regulations or other legally binding requirements. In the event of a conflict between the discussion in this document and any statute or regulation, this document would not be controlling.

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Copies of this guidance can be downloaded from http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/regulation_revisions.cfm.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AGI	Acute gastrointestinal illness
AMWA	Association of Metropolitan Water Agencies
ANSI	American National Standards Institute
ASDWA	Association of State Drinking Water Agencies
AWWA	American Water Works Association
BAT	Best available technology
DBPs	Disinfection by-products
CCCBFP	Cross-connection Control and Backflow Prevention
CFR	Code of Federal Regulations
CSIS	Customer service information system
CWS	Community water system
EPA	Environmental Protection Agency
GIS	Geographic information systems
GWR	Ground Water Rule
GWUDI	Ground water under the direct influence of surface water
HAA5	Haloacetic acids
HPC	Heterotrophic plate count
HRT	Hydraulic residence time
IESWTR	Interim Enhanced Surface Water Treatment Rule
LCR	Lead and Copper Rule
LIMS	Laboratory information management system
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
MMIS	Maintenance management information system
MRDL	Maximum residual disinfectant level
NOM	Natural organic matter
NCWS	Non-community water system
NSF	National Science Foundation
NTNCWS	Non-transient non-community water system
O&M	Operations and maintenance

PN	Public notification
PWS	Public water system
RTCR	Revised Total Coliform Rule
SCADA	Supervisory control and data acquisition
SDWA	Safe Drinking Water Act
SOPs	Standard operating procedures
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
TTHM	Total trihalomethanes
VFD	Variable frequency drive

1. Overview of this Manual

1.1. What is the purpose of this manual?

Under the Revised Total Coliform Rule (RTCR) (USEPA 2013 and USEPA 2014) (40 CFR[1] part 141 subpart Y), a public water system (PWS[2]) that is vulnerable to microbial contamination (as indicated by its monitoring results) is required to conduct assessment and corrective action of the system to identify and correct any sanitary defects[3] in the distribution system or treatment processes (40 CFR 141.859). This document provides PWSs with guidance on implementing the assessment and corrective action requirements of the RTCR.

The guidance is intended for use by PWS owners and operators. States,[4] other primacy agencies and technical assistance providers may also benefit from reading this guidance.

1.2. What is the Revised Total Coliform Rule (RTCR)?

The RTCR is a revision of the Total Coliform Rule (TCR), which was promulgated in 1989. The RTCR retains the objectives and the basic monitoring requirements of the TCR but offers greater public health protection by the addition of new requirements. The changes include the following:

- The health goal and legal limits[5] for the presence of total coliforms in drinking water have been replaced with a treatment technique that requires PWSs to conduct an assessment of their system if monitoring results indicate that they might be vulnerable to contamination and to correct for any problems identified during the assessment.

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[1] CFR – Code of Federal Regulations

[2] PWS and system are used interchangeably throughout this document.

[3] Sanitary defect as defined at 40 CFR 141.2 – A defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure in a barrier that is already in place. See 40 CFR 141.851. See Chapter 2 of this document for a more detailed discussion of sanitary defects.

[4] In this document, "state" is used to generally refer to the primacy agency, whether it be the state agency, the Tribal government or the Environmental Protection Agency (EPA) (40 CFR 141.2). A primacy agency is the entity that has the primary responsibility for administering and enforcing regulations under the Safe Drinking Water Act (SDWA) in a given jurisdiction. In many cases, the state agency is the primacy agency. For Tribes and states or territories that have not been granted primacy enforcement authority, EPA is the primacy agency for administration and enforcement of the RTCR.

[5] These are the maximum contaminant level goal (MCLG) and maximum contaminant level (MCL), respectively. The MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur and which allows an adequate margin of safety. The MCL is the maximum permissible level of a contaminant in water which is delivered to any user of a public water system. (40 CFR 141.2)

- Small ground water systems need to meet specific criteria to remain on a reduced monitoring schedule.

- High risk small systems with unacceptable compliance history are required to increase their monitoring.

- Seasonal systems, which do not serve water to the public all year round, such as some campgrounds and state and national parks, are required to comply with new requirements to address the additional vulnerability to microbial contamination in these systems due to their operating characteristics.

For more information on the other requirements of the RTCR, go to **Appendix A** of this document.

1.3. Who needs to comply with the RTCR?

All PWSs (community or non-community) regardless of the type of source water use (i.e., surface water, ground water or ground water under the direct influence of surface water (GWUDI)) are required to comply with the RTCR (40 CFR 141.851(b)).

1.4. How is this document organized?

The document is organized as follows:

- **Chapter 1 – Overview of this Manual.** This chapter introduces the guidance manual and summarizes each section of the document.

- **Chapter 2 – Assessment and Corrective Action under the Revised Total Coliform Rule.** This chapter provides an overview of the assessment and corrective action requirements of the RTCR (including the schedule for and who must conduct assessments), discusses how a contamination can occur in the distribution system, discusses what a sanitary defect is and gives examples of sanitary defects.

- **Chapter 3 – Level 1 Assessment.** This chapter discusses what a Level 1 assessment is, when is it required, why it needs to be conducted, who can conduct it, how to document it, what steps can be followed to conduct one and what the timeline is for completing it.

- **Chapter 4 – Level 2 Assessment.** This chapter discusses what a Level 2 assessment is, when is it required, why it needs to be conducted, who can conduct it, how to document it, what steps can be followed to conduct one and what the timeline is for completing it. It also discusses the differences between a Level 1 and Level 2 assessment.

- **Chapter 5 – Corrective Action.** This chapter discusses requirements and provides guidance related to the identification and correction of sanitary defects, particularly those in the distribution system. It also provides guidance related to actions that systems could take regardless of the outcome of the assessments.

- **Chapter 6 – Simultaneous Compliance with the RTCR with the Requirements of Other Drinking Water Rules.** This chapter discusses the considerations systems should take into account when complying with the RTCR and how those could affect their compliance with other drinking water rules.

- **Chapter 7 – References**

- **Appendix A – Summary of the RTCR Requirements.** This appendix provides a summary of the requirements of the RTCR in a tabular format.

- **Appendix B – Example Assessment Forms.** This appendix provides concept examples of Level 1 and Level 2 assessment forms. State primacy agencies may develop their own forms for use by PWSs under their jurisdiction.

- **Appendix C –Examples of Completed Assessments.** This appendix goes through some examples of systems being triggered into conducting an assessment and shows how the assessment forms are filled out.

- **Appendix D – Industry Standards for Operating a Public Water System.** This appendix provides a list of standards that may help systems complete a corrective action.

2. Assessment and Corrective Actions under the Revised Total Coliform Rule

2.1. Why does the RTCR require assessment and corrective action?

The RTCR aims to increase public health protection through the reduction of defects that could either provide pathways that allow fecal contamination and/or waterborne pathogens to enter into the distribution system, or could indicate a failure or imminent failure in a barrier that is already in place. The RTCR uses the term **sanitary defects** to refer to these deficiencies.

The RTCR requires all PWSs to monitor for total coliforms and *E. coli* in their distribution system on a regular basis. Total coliforms are used as indicators of the integrity of the distribution system and *E. coli* as an indicator of the presence of fecal contamination. Refer to Section III.B of the preamble to the final RTCR for more discussion on the use of total coliforms and *E. coli* in the RTCR (USEPA 2013 and USEPA 2014).

If the monitoring results indicate that the system may be vulnerable to fecal contamination (e.g., multiple positive results for total coliforms or *E. coli*), the system must conduct an assessment to determine if there are sanitary defects that could be causing the contamination. If there are no sanitary defects found, there may be problems in the sampling practices. Refer to **Section 3.1** and **Section 4.1** of this document to find out when a PWS must conduct an assessment. Any sanitary defects identified during the assessment must be corrected to prevent future occurrence of contamination.

> Conducting an assessment and correcting for identified sanitary defect(s) should lead to a reduction of the pathways and the conditions that may allow the entry of contaminants into the distribution system.

Fecal contamination and waterborne pathogens (such as bacteria, viruses and parasitic protozoa) can cause a variety of illnesses, including acute gastrointestinal illness (AGI) with diarrhea, abdominal discomfort, nausea, vomiting and other symptoms. In general, reduction of the pathways and conditions that allow the entry of contaminants into the distribution system should lead to reduced exposure and associated risk from these contaminants.

2.2. What causes a contamination to occur?

There are numerous factors that can contribute to the presence of coliforms and *E. coli* in the distribution system. Coliform bacteria may be present in the distribution system if three conditions simultaneously occur (see **Figure 2-1**):

1. A source of coliform bacteria;
2. A pathway into the distribution system or a breach in the system's physical integrity; and
3. A mechanism that allows coliform bacteria to be carried on this pathway into the distribution system or that allows bacteria within biofilms, corrosion tubercles or sediment to break free and enter the water.

Sources of coliform bacteria can include:

- Soil and Water Surrounding the Pipes – Coliform bacteria are common in the soil and water surrounding pipes, valves and other distribution system infrastructure.
- Biofilms and Microbial Growth - Coliforms may attach to or become enmeshed in biofilms on pipe walls in distribution systems, where they are protected from disinfectants. Over time, these coliforms (including their associated pathogens) may detach or slough from biofilms, causing persistent detections and possibly waterborne disease.
- Corrosion Tubercles - A number of cases have been documented showing the presence of coliform bacteria present within corrosion tubercles (i.e., deposits of corrosion products on the interior of the pipes).
- Customer Connections - Customer connections and premise plumbing, such as the service line connections to schools, hospitals, public and private housing and other buildings, can be the source of coliform bacteria when a backflow event has occurred and water and contamination from the building pipes are drawn back into the public water distribution system, due to a change in pressure.
- Materials Used in the Distribution System - In some instances, materials used in the distribution system can result in the presence of total coliforms through contamination of the materials prior to installation (e.g., instances of well contamination by not disinfecting the pump prior to installation). Some materials may also support the growth of coliforms by providing nutrients for microbial growth (e.g., pipe gaskets and elastic sealants containing polyamide and silicone can be a source of nutrients for bacterial proliferation (NRC 2006)).
- Sediments - Sediment accumulation can provide a habitat for microbial growth in a distribution system. Furthermore, the sediments can protect the microbes from disinfectants.

Pathways through which total coliform bacteria can enter the distribution system can be:

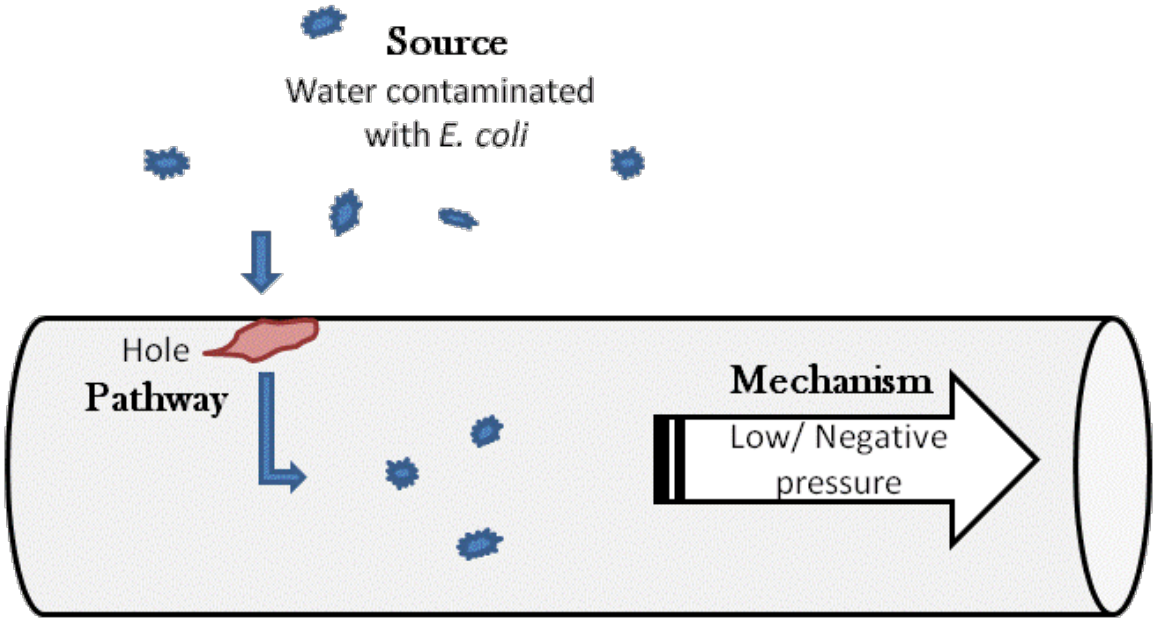
- Finished Water Storage Facility Deficiencies - Storage tank deficiencies, such as vents without screens, inadequate hatches, access hatches that are not locked, physical openings in storage tank roofs and lack of a cover, can result in the entry of contaminants. Microorganisms can also be introduced into underground storage facilities from surface water or ground water infiltration or runoff.
- Unprotected Cross Connections - A cross connection is a pathway whereby a connection exists between a non-potable water source and a potable source (e.g., the PWS). If not protected by an adequate backflow prevention device, the cross connection can be a pathway for bacteria to enter the potable water distribution system.
- Intrusion - Leaks or small holes in the pipe can provide a pathway for contaminants outside of a pipe to enter the distribution system during low and negative pressure events (termed intrusion). Points through which intrusions can occur also include pipe fracture cracks, leaking joints, submerged air-vacuum/air-release valves and deteriorating seals.
- Improper Main Installation, Repair or Replacement - Main installation, repair or replacement can result in a loss of pressure and exposure of the pipe interior to contaminated soil and runoff. If sanitary procedures are not followed, contaminants can be introduced into the pipes during the main break repair process.

Mechanisms that allow coliform bacteria to enter the distribution system (assuming a source of contaminants and a pathway are present) or that allow bacteria to proliferate in the distribution system include the following:

- Weather-Related Events - A range of different weather-related events can contribute to the increase of total coliforms and sometimes fecal indicators in source waters. In other cases, coliforms may enter the distribution system more directly. Types of weather-related events that have been attributed to indicator-positive samples include significant rainfall events, droughts and excessively warm or cold weather.
- Treatment Breakthrough - Failure of the treatment barrier can lead to the presence of coliforms in the distribution system.
- Backflow – An unprotected cross connection that allows the backflow of non-potable water to enter the potable system because of reduced pressure in the distribution system (termed backsiphonage) or the presence of increased pressure in the non-potable system (termed backpressure).

- Hydraulic Conditions - Contaminant intrusion may occur if a very low or negative pressure occurs within the pipe. Low pressure conditions in the distribution system can also allow a flow reversal or backflow of non-potable water to enter the system from a cross connection or other source such as intrusion.
- Operations - Sudden velocity or flow direction changes during operational activities within a distribution system can result in the release of biofilms, scales or sediments with microbial contamination. These velocity and flow changes are sometimes related to firefighting, valve exercising and changing from one source to another.
- Maintenance Practices – Maintenance practices such as flushing and line cleaning can affect the distribution system water quality in a negative manner if not conducted properly and improper flushing can result in moving a contaminant further into the distribution system.
- Retention Times - Long retention time in the distribution system, including storage facilities, can reduce the levels of disinfectant residual and allow for the deposition and accumulation of sediment.
- Presence of Nutrients - Some materials or system operations can introduce nutrients such as carbon, nitrogen and phosphorus into the distribution system that may support growth of total coliform bacteria.

Figure 2-1: Example of How Contamination Can Get Into a Water Pipe When All Three Conditions Are Present



Additional information on the causes of coliforms and *E. coli* in the distribution system can be found in a series of issue papers and white papers located at *http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/regulation_revisions.cfm#issuepapers*

2.3. What are examples of sanitary defects?

Proper operation and maintenance of the distribution system is the last protective barrier to microbial contamination of drinking water. If the distribution system is breached via sanitary defects, microbial contamination can enter the treated water and be transported to customers, potentially resulting in adverse health outcomes. That is why it is so important to prevent sanitary defects and eliminate them when they occur.

Examples of sanitary defects can include:

Cross connection and backflow issues

- Required cross connection control devices not in place or not operating properly
- Unprotected cross connection (e.g., hoses connected from the hydrant to the raw sewage masher spray bar in a wastewater facility; potable water plumbed directly to the raw waste system in a recreational vehicle)
- Unauthorized connections to water mains

Operational issues

- Failure to follow Standard Operating Procedures (SOPs) that protect distribution system integrity and sanitary condition
- Inadequate disinfection during and after pipe repair/replacement activities
- Failure to monitor and replace chlorine supply
- Improper chlorine residual measurements
- Sample collection and transportation problems
- Failure to follow sample siting plan
- Use of unapproved or untested source of water
- Untrained sample collector

Distribution system issues

- Inadequate inspection and maintenance of distribution system
- Loss of distribution system integrity (e.g., main breaks)
- Failure to maintain adequate pressure or low pressure event
- Pump failure

- Supervisory control and data acquisition (SCADA) and control issues
- Improper or lack of flushing operations
- Improper construction of new, replaced or renovated lines or service connections

Storage issues

- Overflow, vents, hatches and other penetrations not configured, screened or sealed properly
- Holes in tanks that could allow entry of insects or small animals
- Leaks in tanks that could be harboring growth
- Bladder pressure tanks that can become waterlogged
- Inadequate inspection and maintenance of storage facilities
- Inadequate disinfection during and after pipe repair/replacement activities

Source water issues

- Cracks or holes in well seals or casings
- Leaking sewer lines or septic tanks
- Sewage overflow upstream of the source
- Lack of wellhead protection
- Unsanitary conditions at the wellhead
- Contamination during pump or motor repair or replacement
- Watertight seal at wellhead not present

Disinfection issues

- Inability to maintain required residual throughout the distribution system
- Failure of chlorination equipment
- Improper settings on chemical feed
- Failure in redundant disinfection
- Loss of power

This is not an exhaustive or binding list. Systems should check with their states as they may have an additional or different list of conditions that they consider “sanitary defects.”

Figure 2-2: Examples of Sanitary Defects

Cracks on a fiberglass tank

Rat droppings around the wellhead

Seal on wellhead not watertight

Photos courtesy of Nevada Division of Environmental Protection

2.4. What types of assessments are PWSs required to conduct?

Systems are required to conduct either a Level 1 or Level 2 assessment depending on the condition that triggered the assessment. A Level 2 assessment is triggered by conditions that pose a more immediate and/or more severe public health risk compared to conditions that trigger a Level 1 assessment. Therefore, the Level 2 is a more detailed assessment than a Level 1 assessment and may involve more effort and resources. The two levels of assessment recognize

the difference in the severity of the situation and the varying level of effort required for the assessment.

Whether it is a Level 1 or Level 2 assessment, systems must complete the assessment and the assessment form required by the state and must submit the form to the state within 30 days of triggering the assessment.

For more information on how to conduct a Level 1 assessment and a Level 2 assessment, go to **Chapter 3** and **Chapter 4**, respectively, of this guidance manual.

2.5. What happens if a sanitary defect is identified during an assessment?

If a sanitary defect is identified during the assessment, the system is required to take corrective actions to address the defect. If there are multiple sanitary defects identified, the system is required to correct all those sanitary defects. **Chapter 5** of this guidance manual discusses some of actions that can be taken depending on the type of sanitary defect that has been identified.

Sanitary defects detected, corrective actions completed and a proposed timetable for any corrective actions not already completed must be included in the assessment form that is due to the state within 30 days of triggering the assessment. Systems must comply with the required time period in conducting the assessment and taking the corrective action.

2.6. What if no sanitary defect is identified?

It is possible that even after conducting an assessment, the positive sample cannot be conclusively linked to a given sanitary defect due to the complexity of the distribution system configuration and/or transport of contaminants throughout the system. In this case, this conclusion must be documented in the assessment form. The state may require the system to provide supporting documents to back up its conclusion. Even though a sanitary defect might not be identified, the Environmental Protection Agency (EPA) recommends some best practices that systems might consider performing after they have been triggered to conduct an assessment but did not find any sanitary defect. **Section 5.3** of this document lists some of these best practices that can be taken.

3. Level 1 Assessments

3.1. What is a Level 1 assessment?

A Level 1 assessment[6] is a basic examination of the source water, treatment, distribution system (including storage facilities) and relevant operational practices. It is intended as a self-assessment and will be performed by a responsible party of the system in most cases (40 CFR 141.859(b)(3)).

A Level 1 assessment is triggered if sampling results in any one of the following scenarios (40 CFR 141.859(a)(1)):

1. For systems collecting 40 or more samples per month, the number of total coliform-positive samples exceed 5.0% of the total coliform samples collected for the month (including routine and repeat samples); or
2. For systems collecting fewer than 40 samples per month, there are two or more total coliform-positive samples in the same month (either routine or repeat); or
3. For any system, the system fails to take every required repeat sample after any single routine total coliform-positive sample.

3.2. Why do systems need to conduct a Level 1 assessment?

The purpose of performing a Level 1 assessment is to enhance public health protection by identifying the presence of **sanitary defects** and correcting all such defects identified. Performing assessments will also help identify if there are deficiencies or problems in the sampling practices (40 CFR 141.859(b)(1)).

Sanitary defects are defined as: defects that could provide a pathway of entry for microbial contamination into the distribution system or that are indicative of a failure or imminent failure in a barrier that is already in place (40 CFR 141.2).

[6] Level 1 assessment is defined at 40 CFR 141.2 as "an evaluation to identify the possible presence of sanitary defects, defects in distribution system coliform monitoring practices, and (when possible) the likely reason that the system triggered the assessment. It is conducted by the system operator or owner. Minimum elements include review and identification of atypical events that could affect distributed water quality or indicate that distributed water quality was impaired; changes in distribution system maintenance and operation that could affect distributed water quality (including water storage); source and treatment considerations that bear on distributed water quality, where appropriate (e.g., whether a ground water system is disinfected); existing water quality monitoring data; and inadequacies in sample sites, sampling protocol, and sample processing. The system must conduct the assessment consistent with any State directives that tailor specific assessment elements with respect to the size and type of the system and the size, type, and characteristics of the distribution system."

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.

Ideally, a well-performed Level 1 assessment will prevent most systems from developing conditions that lead to fecal contamination or a Level 2 assessment. For guidance on Level 2 assessments, see **Chapter 4** of this document.

For systems eligible to monitor at a reduced frequency (i.e., less than monthly; see 40 CFR 141.854 and 141.855), it is also important that they conduct a Level 1 assessment within the specified timeframe (see **Section 3.6** of this document regarding the timeframes associated with the Level 1 assessment) as failing to do so might result in them being placed into more frequent monitoring. Also keep in mind that if a system's monitoring frequency has been increased to monthly, the system needs to have a clean compliance history (i.e., no history of RTCR violations within the last 12 months) to be able to return to a reduced monitoring frequency. Failure to conduct a Level 1 assessment within the required timeframe and according to the state requirements is a treatment technique violation, which disqualifies a system from having a clean compliance history. Also, keep in mind that a treatment technique violation under the RTCR has an accompanying requirement to notify the public. **Appendix A** of this document presents a summary of the RTCR requirements.

If a system has qualified for reduced monitoring, it can remain on the reduced monitoring schedule if it does not have more than one Level 1 assessment triggered per rolling 12-month period.

3.3. Who is responsible for conducting a Level 1 assessment?

A Level 1 assessment is a PWS self-assessment that should be conducted or managed by a responsible party of the PWS (40 CFR 141.859(b)(3)). This should be someone familiar enough with the system to answer the questions in the Level 1 assessment form or to gather correct information from others who work for the system. Systems may also seek assistance from external parties, if desired. External assistance may be provided by state personnel, a certified operator from a similar system, a circuit rider, consultant or other utility expert.

Remember that the assessment must be consistent with state requirements so systems should check with their states to make sure that they have the appropriate person conducting the Level 1 assessment.

3.4. How do PWSs document a Level 1 assessment?

The Level 1 assessment must be documented using an assessment form, which systems must complete and submit to their states within 30 days after they have learned that they have exceeded a trigger (40 CFR 141.859(b)(3))**.**

Appendix B of this document contains an example of a Level 1 assessment form. The sample form is intended as a conceptual example to describe practical expectations for the level of resources committed to undertaking a Level 1 assessment. States can use the example form presented in this document or develop their own forms. It is possible that states have different forms that are specific to different system types. **Systems should contact their states to make sure that they are using the right form.**

Systems must submit a Level 1 assessment form to their states within 30 days after learning that they have exceeded a trigger. The assessment form must describe sanitary defects detected, corrective actions completed, and a proposed timetable for any corrective actions not completed. If no sanitary defects were detected, systems may note in their form that no sanitary defects were identified (see **Section 2.6** of this document). See 40 CFR 141.859(b)(3).

The example assessment form is designed to cover the typical elements found within a PWS. For each element, the assessment form provides suggestions on items to evaluate that are related to the pathways and mechanisms for microbial contamination. Since an assessment is an examination of a particular PWS, it will therefore have different components for each system depending on the system's source water, configuration and the number and type of distribution system facilities present. The form cannot cover all possible situations or distribution system configurations. Systems should use professional judgment in the application of the form to their situation and provide additional information to support conclusions, if warranted.

The state makes the final determination on the adequacy and completeness of information provided in the assessment (40 CFR 141.859(b)(3))**.** The state will review the assessment form and if it determines that the assessment is insufficient, it will consult with the system on follow-up efforts that may be required. Systems should be familiar with the forms and required submittals so that they are prepared for an assessment in advance, should one be required. For example, systems may wish to create a standard operating procedure (SOP) for what to do when coliform results trigger an assessment. When developing the SOP, systems

should verify with their states whether there is a specific version of the assessment form that needs to be used, and understand which data source(s) can be used to fill out the various sections.

3.5. How do PWSs conduct a Level 1 assessment?

At a minimum, a Level 1 assessment must include a review and identification of the following **elements** (40 CFR 141.859(b)(2)):

- Atypical events that may have affected distributed water quality or indicate that distributed water quality was impaired (see **Section 3.5.2** of this document).
- Changes in distribution system maintenance and operation that may have affected or are affecting distributed water quality including water storage (see **Section 3.5.2** of this document).
- An evaluation of source water quality and treatment changes or conditions that may affect distributed water quality, where appropriate (see **Sections 3.5.3** and **3.5.4** of this document).
- Existing water quality monitoring data (see **Section 3.5.2** of this document).
- Inadequacies in sample sites, sampling protocol and sample processing (see **Section 3.5.1** of this document).

The Level 1 assessment form example found in Appendix B of this document lays out the elements of the system that need to be looked at during an assessment and gives an idea of the depth and level of detail that is expected of the assessment. States may also tailor specific assessment elements to the size and type of system. Systems may tailor their assessment activities based on the specific characteristics of their distribution system, in accordance with state requirements. As stated previously, the form is provided as an example only. **Systems should contact their states to obtain the specific forms for their situation**.

If the state allows it, systems may conduct a Level 1 assessment while they consult with the state by phone. It is possible that the state may fill out the assessment form for the system while the consultation is happening. If not, the system would still need to fill out the assessment form and submit it to its state. Systems should check with their state to see if there are alternative methods they can use to submit the form, e.g., via an online submission or email.

For the Level 1 assessment, the assessor should look at conditions that could have occurred prior to the collection of the total coliform-positive sample(s). **A Level 1 assessment can often be completed using data on hand at the PWS, with the assessor conducting limited inspections, and not necessarily conducting extensive new field investigations.** Interviews of appropriate PWS employees can also be a valuable means of obtaining important information.

The assessor should begin the assessment by evaluating the sample site itself. The assessor should review the sampling procedures, laboratory procedures and conditions of the sampling tap and note any errors and unsanitary conditions. The area immediately surrounding the positive sample site(s) should be evaluated next. Historical water quality data should be examined along with a list of events that may have occurred in the vicinity of the positive sample sites to determine a possible cause for a loss of distribution system integrity. The assessment of the distribution system area could include additional sampling to try to identify the extent of the contamination, being sure to consider that the contamination may have migrated within the system. Next, the assessor should evaluate the impact of treatment plant issues or other system-wide events based on historical performance data, environmental factors, operational activities and other external events. Customer complaint data, main break reports and other system data may be helpful in the assessment of system-wide events that could have contributed to degraded water quality. The assessor should evaluate changes in the source water, along with weather events or other occurrences that could influence source water quality.

In general, in performing a Level 1 assessment systems should follow a progression starting with the **(1) location of the initial coliform positive samples** and working through the **(2) distribution system** to the **(3) treatment plant** and **(4) source**. See **Figure 3-1.**

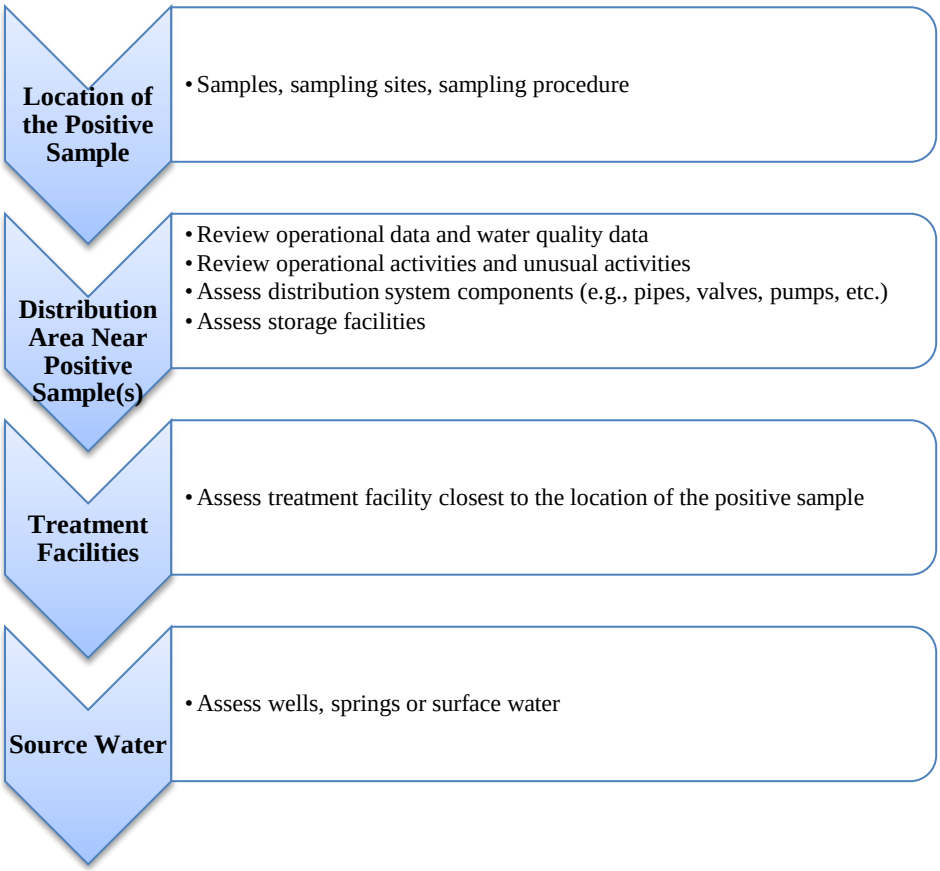
Depending on the system's configuration, not all these components may be present.

The subsequent sections will go into detail on how the assessor can assess the different parts of the water system using the progression outlined above.

The assessor should go over and complete the entire assessment form, even if the apparent cause is understood, to ensure that he/she has a complete picture of the overall integrity of the system and does not inadvertently overlook a potential sanitary defect. It is also possible that the coliform positive samples resulted from multiple causes.

Once an assessment has been triggered, system personnel may become busy performing the investigation, answering questions and responding to the public, on top of their normal daily responsibilities. **Therefore, systems should prepare for a possible assessment by developing some standard datasets based on operational data for items such as disinfectant residuals, treatment process variables and field sampling results.** Much of this data can typically be found in monthly operating reports and other summaries that are submitted to the states. These datasets should be continuously updated so that they are ready to be used immediately upon triggering an assessment. For further discussion on operational data, see **Section 3.5.2.1** of this document.

Figure 3-1: General Progression of Conducting a Level 1 Assessment



3.5.1. Assessing samples, sampling sites and sampling protocols

This section of the assessment is designed to help the assessor determine whether water samples could have been contaminated during the sample collection or processing, resulting in total coliform- or *E. coli*-positive samples. In that case, the positive results may not indicate a distribution system problem but rather a sampling problem. Several references are available to provide detailed guidance on sampling (AWWA 2008; APHA et al. 2005; USEPA 2001a; USEPA 2006c; USEPA 2006d).

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.

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. This part of the

assessment should include a field visit to inspect the sample location(s) or a detailed discussion with the sample collector to determine the conditions at the sample site(s).

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

- Cleanliness and suitability of the sample tap and 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.

In addition to sample tap contamination, it is possible that elements of the sampling protocol that were not followed closely could result in contamination of the sample. **Elements of the sampling protocol** that systems should follow may include:

- Removal of the tap aerator,
- Adequate flushing of the tap prior to sample collection,
- Proper storage and preparation of the sampling container,
- Correct sample collection technique, including elimination of splashing water from sink and the sampler touching the inside of the sample bottle,
- Correct storage, preservation and handling of sample(s) during transport to laboratory, including items such as cleanliness of coolers and use of watertight bottles during transport (to prevent leakage), and
- Compliance with holding time and temperature requirements, including items such as maintenance of ice packs.

Finally, this evaluation should include a discussion with the laboratory to determine if all laboratory quality checks were performed with satisfactory results.

3.5.2. Assessing the distribution system area near the positive samples

Once the evaluation of the sample site(s) has been completed, the assessor should proceed to 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.

A Level 1 assessment of the distribution system should include the collection and review of available data. The data to be reviewed includes **operational data** (e.g., pressures, flows),

water quality (e.g., pH, turbidity, etc.) and **information on the physical condition of distribution system components** (see **Sections 3.5.2.1** to **3.5.2.5** of this document).

The area of the distribution system that should be evaluated 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.

3.5.2.1. Operational data

The operational data review includes collection, compilation and analysis of the system data from a variety of sources to get a more complete understanding of the system conditions and events that may have occurred prior to triggering an assessment. The data collected should include recent data as well as historical trends to provide a basis for comparison to determine if atypical events such as main breaks or system component failures have occurred.

The **operational data elements** should be reviewed by all systems, regardless of size or type. The available data and accessibility of electronic data may vary by system size and type.

Larger systems may have electronic databases from which to extract pertinent information including:

- Distribution system and treatment plant process data from SCADA systems for pumping, storage and pressure data,
- Water quality measurements from laboratory information management systems (LIMS) or external laboratory reporting systems,
- Customer complaint and water usage data from customer service information systems (CSIS),
- Data on operations and repairs in the distribution system from maintenance management information systems (MMIS),
- Recent and historical information from main break databases,
- Pipe material and condition information from asset management databases,
- Hydrant testing and fire-fighting from fire department information, and
- Activities performed from operations logs.

For smaller systems, much of the data sources listed above may not be electronic and would thus involve additional effort by the system to compile the data as part of the assessment.

EPA encourages these types of systems to maintain records of the above-mentioned data elements to help them quickly conduct an assessment, should they be triggered to do one.

The operational data review may provide an indication of the elements of the assessment on which to focus the assessor's efforts. For example, if the SCADA data or other available information indicates some low-pressure readings in a particular area of the distribution system, follow-up investigations could focus on that area. However, the assessor should not ignore other areas of the distribution system as microbial contamination can be a result of multiple causes.

Tables and graphs summarizing the data and findings could be helpful supplemental items to prepare and submit to the state, if a system is asked or required to do so. Although systems, under the federal regulations, are not required to submit the collected data and supplemental analysis with the assessment form, EPA recommends that these items be kept on file for future reference in case the system gets triggered for another assessment. States may also require the system to submit such data and analysis or may want to look at this information during their review of the assessment forms or during a sanitary survey.

3.5.2.2. Water quality data

As part of any assessment, the assessor should compile and evaluate water quality data. This data would include parameters collected in the distribution system and at the source or treatment plant (discussed further in **Section 3.5.3** of this document). The parameters to be evaluated will likely vary by system type, treatment process used and other operational practices but may include the items outlined in **Table 3-1**. Systems that do not currently collect water quality data at one of the locations suggested in **Table 3-1** might consider doing so in order to create a baseline for comparison should another assessment be triggered in the future.

The assessor may find it appropriate to collect special purpose samples of total coliforms (and potential subsequent *E. coli*) analysis and monitor for additional water quality parameters such as disinfectant residual. An example of a special purpose sample is one taken to determine whether disinfection practices are sufficient following pipe placement, replacement or repair. Records of any special purpose samples taken should be kept for comparison should another assessment be triggered in the future. Take note that special purpose samples, such as those taken during an assessment, must not be counted towards compliance (i.e., they should not be included in determining whether an assessment has been triggered).

Table 3-1: Typical Water Quality Data to Be Evaluated During an Assessment

Water Quality Parameter	Location of Sample Collection
Disinfectant residual concentration	Throughout the distribution system, including total coliform sampling sites as specified in the sample siting plan
	At storage tanks throughout the distribution system
	At the entrance to the distribution system at each source
Disinfection by-products (DBPs)	At approved monitoring locations in the distribution system
Total coliforms and *E. coli*	All distribution system sampling sites, including those for repeat, additional routine and special purpose samples (like those associated with recent main installation or repair)
	Entrance to the distribution system at each source
Heterotrophic plate count (HTP)	All distribution system sampling sites for total coliforms
Nitrite and nitrate (systems using chloramine)	Distribution system sites with low disinfectant residual

Once the water quality and operational data have been collected, they should be evaluated to determine if any atypical events or measured values have occurred. Depending on the data that are available, there may be several ways to examine the data. One good method is to develop a **historical trend** for monitoring results and individual parameters at each sampling location. Spreadsheet and graphing software can be helpful in developing and reviewing historic trends. The historical time series can be evaluated visually to determine if there are differences between current results (under assessment) and historical trends. See **Figure 3-2**.

A **spatial analysis of data** can also help identify problem areas. Mapping of water quality results can be done using a paper map or geographic information system (GIS) software. The correlation between different water quality variables (e.g., disinfectant residual and total coliform) can be more apparent when the data is viewed in a spatial analysis. The results of a spatial data analysis can be used to focus the Level 1 assessment activities on the appropriate areas and components of the distribution system.

Consideration of flow pathways or use of a hydraulic model can also help in determining if a specific activity could be related to the coliform-positive samples at a given

location. This type of analysis can be useful in finding the source of contamination, particularly if several positive samples fall within the influence zone of a specific distribution system pump station or tank. In this instance, the assessor can focus his/her attention on specific locations at the distribution system in determining the cause of the positive samples. However, as mentioned previously, other areas of the distribution system should not be ignored, as the contamination may be a result of multiple causes.

The assessor could also consider **supplemental data** sources beyond water quality measurements in the assessment. For example, customer complaints might show an increase in a particular area of the distribution system that could be correlated to distribution system problems.

Figure 3-2: Example Time Series Graph for Distribution System Chlorine Results

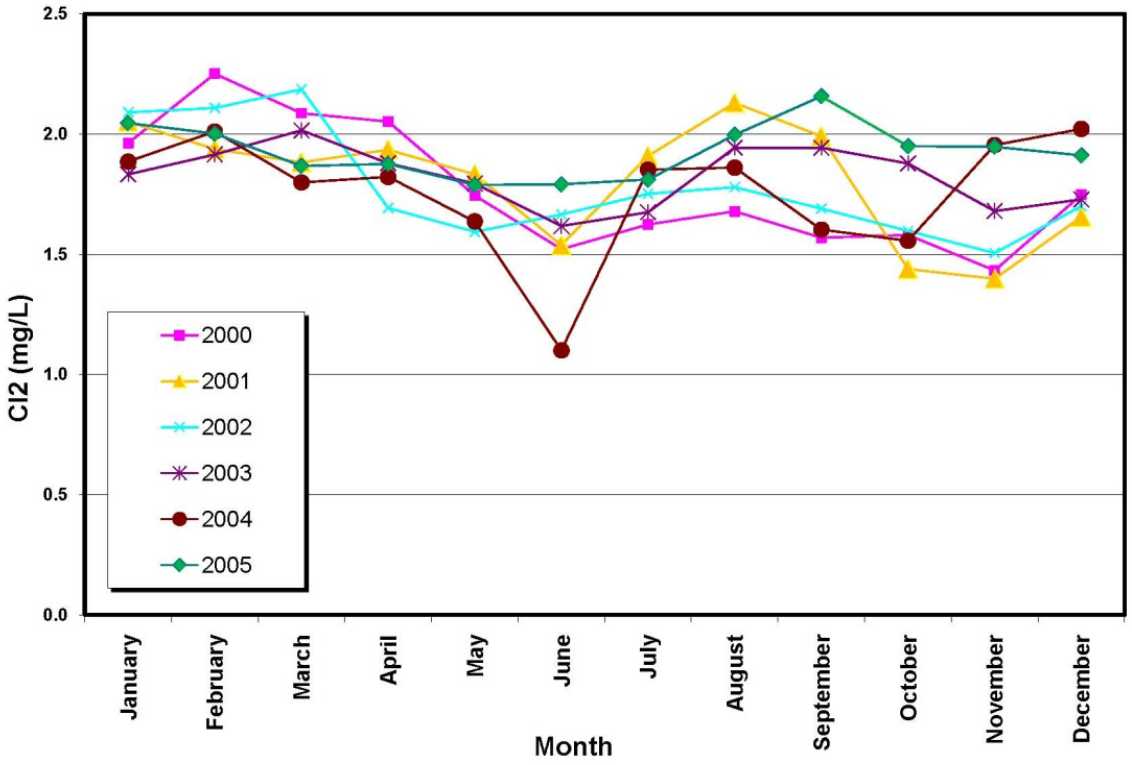


Figure 3-2 provides an example of a historical time series graph of total chlorine measurements from distribution system samples using Microsoft Excel software. The average total chlorine concentration for each month is plotted for multiple years. This type of graph can help to identify if measured values are within normal ranges or might represent an atypical condition within the distribution system. Similar graphs could be constructed for minimum and maximum residual disinfectant measurements, total coliform-positive samples and related water quality sampling data.

3.5.2.3. Operational activities and unusual events

Along with water quality measurements, it is important to understand the extent of activities occurring in the water system that may have resulted in total coliform-positive samples. **Compilation of operational activity data** may require consultation with different departments within the water system and with external agencies. The types of activities and events to be noted would include those that might result in distribution system contamination, including:

- Pipe breaks and associated repairs,
- Events resulting in a loss of pressure (e.g., power failures),
- Flushing and hydrant testing,
- Construction activity that impacts water pipes,
- Unusually high (or low) demands that might alter typical flow patterns, including temporary connections for construction and firefighting,
- Break-ins and vandalism at system facilities,
- Treatment process upsets,
- Weather events, and
- Source water changes.

Once a list of distribution system activities and events has been compiled, this list can be compared to historical records to determine if any activities or events could have led to the distribution system contamination. Any suspect operational activities or events should be further investigated and documented on the assessment form.

3.5.2.4. Assessing distribution system components

The objective of this evaluation is to help determine if a particular distribution system component has a sanitary defect that would require correction or if distribution system events could have contributed to the positive coliform samples.

From the operational data review, data should have been compiled to indicate what activities had been occurring in the distribution system near the location of the total coliform-positive samples, including operational changes, maintenance and atypical events. For a Level 1 assessment for distribution system components, the focus should primarily be on available data that indicates the condition of the component at its last inspection date, observations from recent visits by operations staff and other related data such as disinfectant residual that might assist in focusing the assessment efforts. This would include any previously noted sanitary defects or significant deficiencies and records on how these were addressed. Under this step of the assessment, further detail should be obtained for any location or event that might be significant.

Additional data could be collected to help define the extent of the contamination and to determine whether the contamination has spread. An on-site inspection of components could be considered if it has been a year or more since the last inspection or sanitary survey or if the evaluation of the available data indicates that an on-site inspection is needed.

The assessor should focus first on the area of the distribution system closest to the positive coliform samples. Operator knowledge or the results of a flow path analysis or hydraulic model can be used to determine the area(s) likely to be associated with a given sample site. For example, if the positive sample is located within a defined pressure zone, the entry point to the zone and related facilities should be assessed before moving the assessment to other more remote zones. Once the immediate area has been examined, the assessor can continue to evaluate the areas of the distribution system farther from the positive coliform samples.

The assessor should evaluate distribution system facilities to determine whether infrastructure and equipment are operational and in good repair. The evaluation should include elements such as those presented in **Table 3-2**. The items in **Table 3-2** are not intended to be an exhaustive or binding list but rather a summary of typical distribution system components to help assessors think about the system configuration. Depending on system configuration, not all elements would be present in all systems.

Table 3-2: Typical Items to Evaluate in Distribution System Assessment

Component	Typical Items to Evaluate
Pump stations	Proper operation of pumps and valves
	Recent losses of power
	Recent losses of pressure
	Proper operation of surge control appurtenances
Distribution system pressure	Maintenance of adequate pressure
Air-relief / Air-vacuum valves	Proper operation of valves
	Valve vault free of standing water and debris
Fire hydrants	Proper operation of shut-off valves
	Leaks at connection to lateral piping
Flushing assemblies / Blow-offs	Proper operation of valves
	Leaks at connection to piping
Pipes	Recent main breaks
	Recent leaks
	Recent installation of new mains or construction activity
Distribution system isolation valves	Recent operation resulting in breakage

Appendix C of this document includes an example of an assessment where distribution system problems were found. In this example, the assessment of the distribution system revealed an air release valve submerged in a flooded valve vault. To correct the problem, a permanent sump pump was installed and portions of the system were shock chlorinated.

3.5.2.5. Assessing storage facilities

Storage facilities, or tanks, have been linked to microbial contamination events and therefore are an important component to assess when responding to positive coliform samples (Clark et al. 1996). Microbial contamination can enter storage facilities either through system water or external tank breaches. If contamination is introduced through system water (i.e., transported to the storage facility or tank from a different contamination site), microbes can remain viable and possibly multiply within the tank water and sediments.

Table 3-3 outlines some of the typical items that should be evaluated for storage facilities or tanks. The items in **Table 3-3** are not intended to be an exhaustive or binding list but rather a summary of typical storage facility or tank components to help assessors think about the system configuration. Depending on system configuration, not all items would be present in all systems.

Review of the most recent tank inspection reports, review of operation and maintenance records and operator interviews should provide valuable information for the assessment. If a thorough inspection of the storage facility or tank has not been completed in the recommended timeframe for that facility (usually every three to five years), the system should consider whether a professional cleaning and inspection is appropriate as part of the Level 1 assessment. For systems that use hydropneumatic tanks and/or bladder tanks, these tanks should be maintained and inspected according to manufacturer recommendations. A Level 1 assessment should include review and inspection of maintenance records for these types of tanks.

If warranted, the assessor could also examine historical disinfectant residual data for the tank and its vicinity and collect additional samples for disinfectant residual and/or total coliforms. Depending on the record review and results of additional monitoring, an on-site inspection may be appropriate.

The assessment should initially be focused on the storage facilities that supply the area near the total coliform-positive sample, with evaluation of other more remote facilities as a next step.

Table 3-3: Typical Items to Evaluate at Storage Facilities

Storage Tank Element	Typical Items to Evaluate
Access hatches	Signs of vandalism or forced entry
	Ability of hatch to seal tightly when closed
	Rust, holes or other breaches
Vents	Signs of vandalism or forced entry
	Absence of screen; holes or other breaches in screens
	Rust, holes or other breaches in vent piping and penetration through tank wall
Overflow piping	Rust, holes or other breaches in piping and penetration through tank wall
	Absence of screens; holes or other breaches in screens
Control valves	Correct operation of level control valves, altitude valves and related appurtenances
Tank exterior	Signs of deterioration, rust or other breaches
Tank interior	Integrity of lining material
	Presence and extent of floating material and sediment within tank; existence of microbes within sediment
	Presence of dead animals
Disinfectant residual	Level of disinfectant in tank, ideally at different tank levels

3.5.3. Assessing the treatment facilities

For a PWS operating a treatment plant, even if the only treatment is a chlorinator at a well, assessment of the proper operation of the treatment process is important to determine if a plant upset could be the source of the microbial contamination resulting in positive coliform samples. For most treatment facilities, regulatory data collected for compliance with related treatment requirements (e.g., Surface Water Treatment Rule (SWTR), Ground Water Rule (GWR)) should be available. A review of this data may indicate a potential treatment plant problem that could have allowed microbial contaminants to enter the distribution system.

As part of a Level 1 assessment, the assessor should review the treatment process data and records. When reviewing the treatment data and records, particular attention should be paid to disinfection processes and turbidity removal, as these processes are responsible for the majority of microbial inactivation (Letterman et al. 1999). For disinfection processes, data and

records regarding the disinfectant feed systems and resulting disinfectant concentration should be evaluated to ensure that proper dosing has taken place and desired residuals are maintained. For turbidity removal, data and records regarding coagulation/sedimentation and filtration processes should be evaluated to ensure that microbial contaminants could not have entered the distribution system along with a spike in turbidity. Power outages and other events that disrupt normal operations should also be considered. Depending on the results of the data and records reviews, additional monitoring or site visits may be appropriate.

Table 3-4 provides an overview of the types of data elements that could be reviewed as part of a Level 1 assessment. The items in **Table 3-4** are not intended to be an exhaustive list but rather a summary of typical treatment facility components to help assessors think about the system configuration. Depending on system configuration, not all elements would be present in all systems.

Table 3-4: Typical Treatment Facility Elements to Evaluate

Treatment Facility Element	Typical Items to Evaluate
Equipment (pumps, mixing units, settling units, pipes, valves, chemical feed units, filters)	Status of equipment – operational and maintained in accordance with the treatment plant Operation and Maintenance procedures
	Recent installations or repairs
Treatment Process	Introduction of new sources or changes in the source water
	Recent changes in the treatment process
	Interruptions in treatment – lapses in chemical feed or proper mixing
	Turbidity measurements at all appropriate locations in the treatment process (source, settled water, pre- and post-filtration, finished water, etc.)
	Disinfectant residual measurements and C x T (concentration x time) calculations
	Flow rates at each plant process

Appendix C of this document includes an example of an assessment where a treatment system was determined to be the cause of positive coliform samples. In this case, pressure was lost during regular maintenance of a treatment system and the system may not have been properly disinfected prior to resuming service.

3.5.4. Assessing the source water

To wrap up a Level 1 assessment that began with the sample site and worked backward through the distribution system to the treatment plant, the final component for evaluation would be the source water. The source water can include wells, springs and surface water bodies (see **Sections 3.5.4.1** to **3.5.4.3** of this document). Changes in source water, extreme weather events and introduction of new sources can all be possible causes of microbial contamination. The source water should be evaluated using historical data and system records to determine if the source water has contributed to the coliform positive samples. Additional monitoring and site visits may be appropriate based on the results of the evaluation of the data and records.

3.5.4.1. Wells

For systems served by a well (or wells), the integrity of the well and proper operation of the well system should be verified to ensure that contamination could not have entered the distribution system from the well. The assessor should pay particular attention to potential pathways that would allow the entrance of surface water, soil, animals or other foreign matter into the well. Well inspection records and operation and maintenance records should be reviewed and weather events should be considered if runoff could have affected the well. The well should be constructed to prevent the accumulation of surface water around the well head and prevent inundation during periods of flooding or increased runoff. **Table 3-5** outlines some typical items that should be evaluated for wells. The items in **Table 3-5** are not intended to be an exhaustive or binding list but rather a summary of typical well components to help assessors think about the system configuration. Some elements may not be present depending on the design/configuration of the well and the type of pump in the well.

Table 3-5: Typical Items to Evaluate at Wells

Well Element	Typical Items to Evaluate
Well house / enclosure	Signs of vandalism or forced entry
	Unsanitary conditions like the presence of rodents or other animals
Well cap / Well seal	Tightness of well cap and seals, presence of gaps or openings
Well vent	Vent properly screened, angled to be self-draining and has sufficient height above ground
Well casing	Holes, breaks, corrosion or deformation in casing and welds
Annular grout seal	Missing, sunken, bridged or channeled grout surrounding the well casing
Pump and pump assembly	Attached to casing with no unprotected openings and has watertight seal
Pitless adapter	Integrity of pitless adapter connection
Inundation	Signs of inundation by floodwater or runoff; depressions around wellhead

3.5.4.2. Springs

For systems served by a spring (or springs), the assessment should verify the sanitary condition and proper operation of the spring and associated piping. Typical items the assessor should evaluate for a spring source include:

- Condition of the spring development,
- Impacts from surface water runoff and weather conditions,
- The physical condition of the spring box,
- Impacts from vandalism or forced entry to determine if holes or other breaches could have occurred that would allow for the introduction of microbial contaminants,
- Signs of inundation, including deposits of soil or soil erosion, and
- Signs of small animals, slugs, bugs, etc., in the spring box.

Appendix C of this document includes an example of an assessment where a spring source was contaminated through a broken pipe. In this case, the pipe was replaced to correct the defect.

3.5.4.3. Surface water

Surface water sources can be impacted by extreme weather events that can influence the influent water quality to the treatment plant. Atypical events may impede the ability of the

treatment process to perform as desired and may allow for the introduction of microbial contaminants into the distribution system. Heavy rainfall and rapid snowmelt can carry large soil loads into surface water sources, thereby increasing turbidity and baseline microbial contaminant concentrations. Similarly, flooding can alter the raw water quality and require treatment changes to achieve good finished water quality.

For systems that have multiple surface water sources, a change from one source to another could trigger a treatment upset that might result in microbial contamination entering the distribution system. In performing the Level 1 assessment, the assessor should obtain and review the source water data to determine if atypical surface water quality could have impacted the treatment process.

3.5.5. Additional considerations

EPA recognizes that the process of conducting a Level 1 assessment presented in the preceding sections may not necessarily apply to all types of systems. Because of the complexity and the diversity of the different configurations of PWSs, a one-size-fits-all approach will not be appropriate for all systems. Larger systems will more than likely have all the elements mentioned in the preceding sections while smaller systems may only have some of them. For example, some small ground water systems may only have a well, provide no treatment and have a limited distribution system consisting only of premise plumbing. The process of performing a Level 1 assessment will therefore vary from system to system. This section presents additional considerations systems may want to incorporate in their assessment protocol depending on their system type.

3.5.5.1. Systems with limited or no distribution system

For small systems, it might be the case that they do not have any treatment process or an extensive distribution system. In this case, the Level 1 assessment will only focus on those elements that are present in the system such as the source water (e.g., wells) and the limited distribution system.

For non-community water systems (NCWSs) that have their own source water and do not supply water beyond their premises (typical examples are schools and churches), then an assessment of the pipes inside the building (what is typically considered premise plumbing) is required. Typically in a community water system (CWS), premise plumbing is beyond the control of the PWS. However, in the case of NCWSs, the premise plumbing may be part of the system and if so, must also be included as part of the assessment. One thing the assessor might look for is the presence of cross connections. The majority of backflow events resulting from unprotected cross connections occur in premise plumbing (USEPA 2001b).

In cases where the results of total coliform monitoring also triggered GWR requirements in addition to triggering an assessment under the RTCR, it might be possible to combine the assessments required under both rules into one assessment, as long as the combined assessment complies with the requirements of both rules. Systems should check with their states before performing such a combined assessment. See also **Chapter 6** of this document regarding the overlap between an assessment under the RTCR and a sanitary survey.

3.5.5.2. Large systems

Large systems may want to determine whether the contamination is widespread or localized in the distribution system. If the total coliform-positive samples that triggered the assessment are clustered in one part of the system, the assessor may want to target the assessment to specific sections of the distribution system or facilities. It may not be practical or necessary to conduct an assessment of the entire distribution system. Looking at historical data may also help determine if the problem is episodic or chronic. Knowing so would help determine the type of corrective action the system has to take to address the problem.

3.5.5.3. Wholesale and consecutive systems

For PWSs that purchase water from another system, also known as consecutive systems, the source water can be considered to be the connection(s) from the wholesale (seller) system. During a Level 1 assessment, a review of the records related to the connection (e.g., flows, pressures, water quality parameters if measured) should be performed.

It is also recommended that the consecutive PWS contact the wholesale system to coordinate assessment efforts. The possibility exists that a contamination event occurred in the wholesale system upstream of the connection and that the contamination has migrated to the consecutive system. While the wholesale system would not be required to perform a Level 1 assessment in this case (unless it also exceeded the trigger level for total coliforms), it may be required to conduct source water monitoring under the GWR and may want to voluntarily investigate its system along with the assessment being performed by the consecutive system. Water quality data from the wholesale system at or near the connection point for the consecutive system may also prove to be valuable in the Level 1 assessment.

Similarly, if a wholesale system experiences a total coliform trigger, it should notify its consecutive system(s) if the contamination could have spread to the consecutive system area. Additional samples and data from the consecutive system may help to define the extent of contamination and identify potential problems and sanitary defects.

Consecutive systems may or may not have additional sources and treatment facilities, such as their own wells with treatment or booster chlorination of purchased water. These complicating factors should be considered during the assessment as needed. If additional sources are present, they should be evaluated as described in **Section 3.5.4** of this document, depending on the location of the positive distribution system samples and what areas of the distribution system are fed by which source. If treatment facilities are present, they should be evaluated as described in **Section 3.5.3** of this document. Furthermore, the samples, sampling sites, sampling protocols and distribution system area should be evaluated as described in **Sections 3.5.1** and **3.5.2** of this document.

3.6. What is the timeline for completing the Level 1 assessment?

The Level 1 assessment must be completed as soon as practical after the system learns that a trigger has been exceeded. The system must submit the completed assessment form to the state for review within 30 days after it has determined that a trigger had been exceeded. See 40 CFR 141.859(b)(3). The 30-day timeframe allows for sufficient time for problem identification and potential remediation of the problem in conjunction with the follow-up assessment, in most cases.

Systems must conduct the assessment as soon as practical after learning that they have triggered an assessment. The system has **30 days** from the time it learns of the trigger to complete the assessment (and necessary corrective actions, if possible) and submit the assessment form to the State (with the timetable to complete any remaining necessary corrective actions).

If the state determines that the assessment is insufficient, it must consult with the system. Assessments may be considered insufficient if they are not fully executed (e.g., the conditions at the well were not fully assessed) or if the assessment was incomplete (e.g., not all of the required elements were examined). If necessary after consultation, the system must submit a revised assessment form to the state on an agreed-upon schedule not to exceed 30 days from the date of the consultation. See 40 CFR 141.859(b)(3) and 141.859(d).

For corrective actions not completed by the time of submission of the assessment form (e.g., in the case where parts need to be ordered and may take longer than 30 days to be delivered and installed), the system must complete the corrective action(s) in compliance with a schedule determined by the state in consultation with the system. To facilitate the discussion during the consultation, the system may propose a schedule for the corrective action(s). The system must notify the state when each scheduled corrective action is completed. See 40 CFR 141.859(c) and 141.859(d).

4. Level 2 Assessments

4.1. What is a Level 2 assessment?

A Level 2 assessment[7] is a more detailed examination of the system, its operational practices and its monitoring program and results. **The elements of a Level 2 assessment are the same as those of a Level 1 assessment, but each element is investigated in greater detail** because the incidents that trigger a Level 2 assessment are of a more critical nature and are more likely to result in direct public health impact, as described in **Section 4.2** below. A Level 2 assessment will likely include field investigations, additional sampling and additional inspections of facilities beyond those performed in a Level 1 assessment. The level of effort and resources required to implement the Level 2 assessments will be commensurate with a more comprehensive investigation and a higher-level review of available information and it may involve the engagement of additional parties and expertise (40 CFR 141.859(b)(4)).

The system must ensure that a Level 2 assessment is completed as soon as practical after it is triggered.

A Level 2 assessment is triggered if sampling results in any one of the following scenarios (40 CFR 141.859(a)(2)):

1. An *E. coli* maximum contaminant level (MCL) violation; or
2. Triggering of a second Level 1 assessment within a rolling 12-month period, unless the state has determined a likely cause for the situation that resulted in the initial Level 1 treatment technique trigger and establishes that the system has fully corrected the problem; or
3. A system with approved reduced annual monitoring has a Level 1 treatment technique trigger in each of two consecutive years.

[7] A Level 2 assessment is defined at 40 CFR 141.2 as an "evaluation to identify the possible presence of sanitary defects, defects in distribution system coliform monitoring practices, and (when possible) the likely reason that the system triggered the assessment. A Level 2 assessment provides a more detailed examination of the system (including the system's monitoring and operational practices) than does a Level 1 assessment through the use of more comprehensive investigation and review of available information, additional internal and external resources, and other relevant practices. It is conducted by an individual approved by the State, which may include the system operator. Minimum elements include review and identification of atypical events that could affect distributed water quality or indicate that distributed water quality was impaired; changes in distribution system maintenance and operation that could affect distributed water quality (including water storage); source and treatment considerations that bear on distributed water quality, where appropriate (e.g., whether a ground water system is disinfected); existing water quality monitoring data; and inadequacies in sample sites, sampling protocol, and sample processing. The system must conduct the assessment consistent with any State directives that tailor specific assessment elements with respect to the size and type of the system and the size, type, and characteristics of the distribution system. The system must comply with any expedited actions or additional actions required by the State in the case of an *E. coli* MCL violation."

4.2. Why do PWSs need to conduct a Level 2 assessment?

As discussed in **Section 3.2** of this document, the purpose of performing assessments, either a Level 1 or Level 2 assessment, is to enhance public health protection by identifying the presence of sanitary defects or to identify defects in the sampling practices (40 CFR 141.859(b)(1)). In the case of a Level 2 assessment, it is even more important to conduct them, given that they are triggered by events that either (a) pose a potential immediate acute public health threat (i.e., trigger associated with the presence of *E. coli*) or (b) may pose a potential serious health impact because of the persistence of the contamination (i.e., a second Level 1 trigger). EPA anticipates that Level 2 assessments following triggers associated with the presence of *E. coli* may be more involved than the Level 2 assessments following triggers in which there is no *E. coli* present, given the differing potential of public health concern.

For systems eligible to monitor at a reduced frequency (i.e., less than monthly; see 40 CFR 141.854 and 141.855), it is also important to conduct a Level 2 assessment within the specified timeframe (see **Section 4.6** of this document regarding the timeframes associated with the Level 2 assessment) as failing to do so might result in the system being placed into more frequent monitoring. Also keep in mind that for a system's monitoring frequency has been increased to monthly, the system needs to have a clean compliance history (i.e., no history of violations within the last 12 months) to be able to return to a reduced monitoring frequency. Failure to conduct a Level 2 assessment within the required timeframe and according to state requirements is a treatment technique violation, which disqualifies a system from having a clean compliance history. Also, keep in mind that a treatment technique violation under the RTCR has an accompanying requirement to notify the public. **Appendix A** of this document presents a summary of the RTCR requirements.

> Conducting a Level 2 assessment is important to protecting public health. Failure to conduct it will result in a treatment technique violation that for some small systems will also trigger them to conduct more frequent monitoring.

4.3. Who is responsible for conducting a Level 2 assessment?

Since a Level 2 assessment is triggered by a more significant event, a more comprehensive assessment is therefore needed compared to a Level 1 assessment. The level of effort and resources committed to undertaking a Level 2 assessment, relative to a Level 1 assessment, will be commensurate with the more comprehensive investigation and review of available information and the engagement of additional parties and expertise. With a Level 2 assessment, the party conducting the assessment will likely conduct field investigations, additional sampling and additional inspections of facilities beyond those to be

> The Level 2 assessment must be conducted by a party approved by the state.

performed for a Level 1 assessment. For these reasons, **a Level 2 assessment must be conducted by a party approved by the state due to the higher level of complexity** (40 CFR 141.859(b)(4)(i) and (ii)). The party conducting the assessment could be the state itself, a third party or, if approved, one of the staff or management of the system with the required certification or qualifications specified by the state.

Examples of such approved parties may include:

- State personnel,
- An operator certified by the state to operate a system of similar size, type and complexity,
- Technical assistance provider such as a circuit rider,
- A supervisor or manager from the water system, supported by other experts or employees of the system, and
- A consultant/consulting engineer.

The state will determine its criteria, policies and processes for approval of Level 2 assessors and will determine which of the above parties are appropriate to conduct the assessment given the complexity of the system. Whoever conducts the assessment, whether the system or a third party, must follow the state requirements for conducting the Level 2 assessment. Systems should be aware of who may be the appropriate assessors for their systems so that if the Level 2 assessment is ever triggered, the system does not lose time in identifying who will conduct this assessment. When a Level 2 assessment is triggered, the system should resolve uncertainties about the assessor by consulting with the state as soon as possible.

Qualities of a Level 2 assessor may include:

- An understanding of the objectives and structure of the RTCR,
- An understanding of the nature of the coliform group and *E. coli*, including its sources, control and public health significance,
- A familiarity with bacteriological sampling practices,
- A working knowledge in how to interpret distribution system water quality data,
- A working knowledge in how to interpret distribution system operational data,
- A working knowledge in how to interpret data regarding the source of supply,
- An understanding of disinfection practices and the potential implications of changes in disinfection practices, and
- Familiarity with the water system treatment plant and distribution system.

In general, the assessor needs “working knowledge” to oversee all elements covered by the Level 2 assessment. The depth of the understanding and knowledge required will depend on

the complexity of the system being assessed. For example, a small system with only a well, storage tank and limited distribution system will require a different level of expertise than a large metropolitan water system. While both have operational data, in one case the assessor may be interpreting information manually recorded from a pressure gauge while in the other case the assessor may need a working familiarity with SCADA.

It is important to recognize that in some cases, one individual may not have all the expertise and a team approach may be warranted. It is also worth noting that systems may gain value from having someone outside their system provide a "fresh set of eyes." The state may wish to consider allowing certified operators with the appropriate qualifications to conduct Level 2 assessments at other equivalent systems.

Although, the Level 2 assessment must be performed by someone approved by the state, note that **the system is ultimately responsible for making sure that the assessment is conducted properly and completely**. In all likelihood, the system and the approved assessor will have to work closely together to compile and review all of the information relevant to the successful completion of the assessment at the water system.

4.4. How do PWSs document a Level 2 assessment?

The Level 2 assessment must be documented using an assessment form, which systems must complete and submit to their states within 30 days after they have learned that they have exceeded the trigger (40 CFR 141.859(b)(4)).

Systems must submit a Level 2 assessment form to their states within 30 days after learning that they have exceeded a trigger. The assessment form must describe sanitary defects detected, corrective actions completed, and a proposed timetable for any corrective actions not completed. If no sanitary defects were identified, systems may also note in their form that no sanitary defects were identified (see **Section 2.6** of this document). See 40 CFR 141.859(b)(4).

Appendix B of this document contains an example of a Level 2 assessment form. The sample form is intended as a conceptual example to describe practical expectations for the level of resources committed to undertaking a Level 2 assessment. States can use the example form presented in this document or develop their own forms. It is possible that states have different forms that are specific to different system types. **Systems should contact their states to make sure that they are using the right form**.

The example assessment form is designed to cover the typical elements found within a PWS. For each element, the assessment form provides suggestions on items to evaluate that are related to the pathways and mechanisms for microbial contamination. Since an assessment is an

examination of a particular PWS, it should therefore have different components for each system depending on the system's source water, configuration and the number and type of distribution system facilities present. The form most likely cannot cover all possible situations or distribution system configurations. Systems should use professional judgment in the application of the form to their situation and provide additional information to support conclusions, if warranted.

The state makes the final determination on the adequacy and completeness of information provided in the assessment (40 CFR 141.859(b)(4)). The state may request a consultation with the system if the state deems the assessment as inadequate or incomplete. The state may also direct the system to perform an expedited action or additional actions in cases with significant potential for public health impact, such as in the case of an *E. coli* MCL violation.[8] For example, the state may direct the system to apply temporary disinfection while the assessment is ongoing and before the cause and source of the contamination is determined.

Systems should be familiar with the forms and required submittals so that they are prepared for an assessment in advance, should one be required. For example, systems may wish to create a standard operating procedure (SOP) for what to do when coliform results trigger an assessment. When developing the SOP, systems should verify with their states whether there is a specific version of the assessment form that needs to be used and understand which data source(s) can be used to fill out the various sections.

4.5. How do PWSs conduct a Level 2 assessment?

As with a Level 1 assessment, at a minimum, the Level 2 assessment must include review and identification of the following **elements** (40 CFR 141.859(b)(2)):

- Atypical events that may have affected distributed water quality or indicate that distributed water quality was impaired (see **Section 4.5.2** of this document).
- Changes in distribution system maintenance and operation that may have affected or are affecting distributed water quality including water storage (see **Section 4.5.2** of this document).
- An evaluation of source water quality and treatment changes or conditions that may affect distributed water quality, where appropriate (see **Sections 4.5.3** and **4.5.4** of this document).
- Existing water quality monitoring data (see **Section 4.5.2** of this document).
- Inadequacies in sample sites, sampling protocol and sample processing (see **Section 4.5.1** of this document).

[8] In the case of an *E. coli* MCL violation, the system is also required to issue a Tier 1 public notification (PN). For the requirements of a Tier 1 PN, see 40 CFR 141.202.

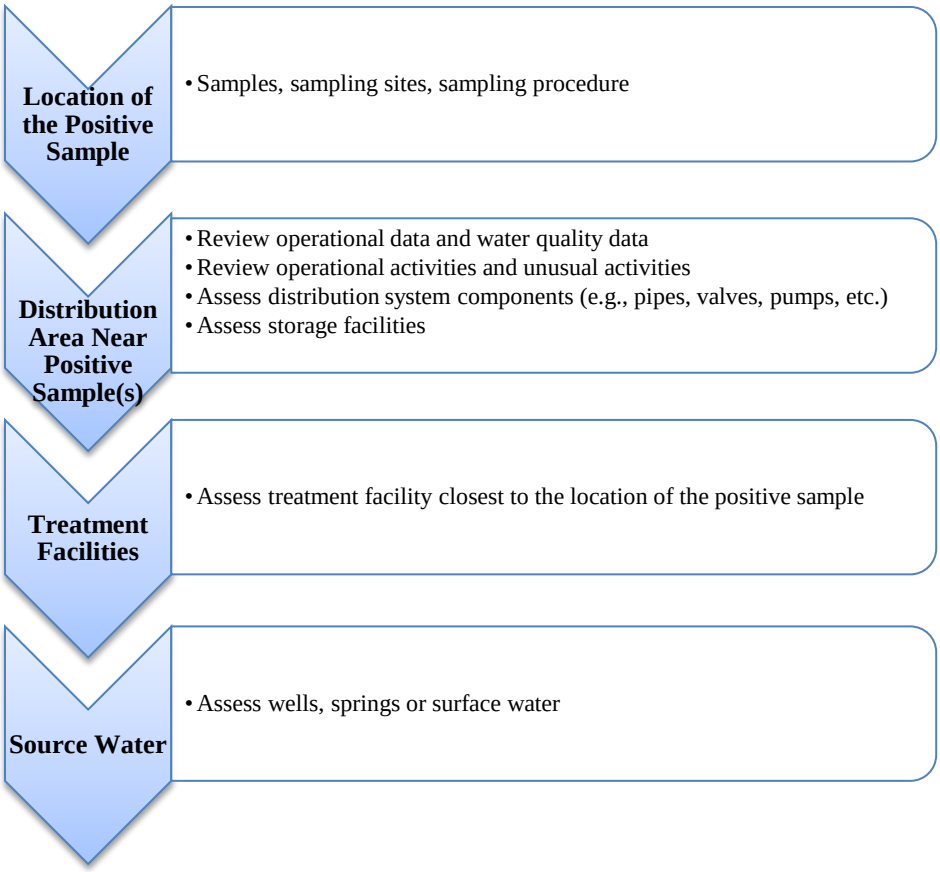
The Level 2 assessment form example found in **Appendix B** of this document lays out the elements of the system that need to be looked at during an assessment and gives an idea of the depth and level of detail that is expected of each assessment. States may also tailor specific assessment elements to the size and type of the system. Systems may tailor their assessment activities based on the specific characteristics of their distribution system, in accordance with state requirements. As stated previously, the form is provided as an example only. **Systems should contact their states to obtain the specific forms for their situation**.

The assessor should begin the assessment by evaluating the sample site itself. The assessor should review the sampling procedures, laboratory procedures and conditions of the sampling tap and note any errors and unsanitary conditions. The area immediately surrounding the positive sample site(s) should be evaluated next. Historical water quality data should be examined along with a list of events that may have occurred in the vicinity of the positive sample sites to determine a possible cause for a loss of distribution system integrity. The assessment of the distribution system area could include additional sampling to try to identify the extent of the contamination, being sure to consider that the contamination may have migrated within the system. Next, the assessor should evaluate the impact of treatment plant issues or other system-wide events based on historical performance data, environmental factors, operational activities and other external events. Customer complaint data, main break reports and other system data may be helpful in the assessment of system-wide events that could have contributed to degraded water quality. Finally, the assessor should evaluate changes in the source water, along with weather events or other occurrences that could influence source water quality.

In general, in performing a Level 2 assessment PWSs should follow a progression starting with the **(1) location of the initial coliform positive samples** and working through the **(2) distribution system** to the **(3) treatment plant** and **(4) source**. See **Figure 4-1** below.

Depending on the system's configuration, not all these components may be present.

Figure 4-1: General Progression of Conducting a Level 2 Assessment



The subsequent sections go into detail on how the different parts of the system should be assessed using the progression outlined above.

Even though both the Level 1 and Level 2 assessments look at the same elements, the Level 2 assessment will require a more comprehensive investigation and the engagement of additional parties and expertise compared to a Level 1 assessment as discussed in **Section 4.3** of this document. **Table 4-1** presents examples of possible differences in the level of effort between a Level 1 and Level 2 assessment.

Table 4-1: Examples of Possible Differences in the Level of Effort Between a Level 1 and a Level 2 Assessment

Level 1 Effort	Level 2 Effort
• Review all monitoring results from appropriate areas of the distribution system for the previous 12 months	• Review all monitoring results from appropriate areas of the distribution system for the previous 12 months • Conduct additional investigatory monitoring
• Review cross connection control records for medium- and high-risk facilities in the area of the positive samples	• Review cross connection control records for medium- and high-risk facilities in the area of the positive samples • Inspect backflow prevention devices in the medium- and high-risk facilities in the area of the positive samples
• Review records of storage tank inspections	• Review records of storage tank inspections • Inspect storage tanks that feed the area of the positive samples
• Review records of inspections of wells and surface water source and weather events	• Review records of inspections of wells and surface water source and weather events • Inspect wells and surface water sources
• Interview sample collectors, distribution system managers, other appropriate employees	• Interview sample collectors, distribution system managers, other appropriate employees • Consult with outside experts, professional engineers • Interview residents and businesses in the area of the positive samples
• Review records of entry point and distribution system disinfectant levels	• Review records of entry point and distribution system disinfectant levels, including historical seasonal changes if any • Conduct additional residual testing at the entry point and appropriate locations in the distribution system
• Review records of distribution system maintenance, especially in the area of the positive samples	• Review records of distribution system maintenance, especially in the area of the positive samples • Inspect on-going maintenance activities
• Notify the state of results and discuss with the state as needed	• Consult with the state about assessment plans and approach, especially if the assessment is triggered by detection of *E. coli*. • Notify the state of results and discuss with the state

Level 1 Effort	Level 2 Effort
• Conduct on-site inspections as indicated by record reviews and interviews above	• Conduct on-site inspections as indicated above

In a Level 2 assessment, the conditions that could have occurred prior to the total coliform-positive sample(s), as well as the current condition of water system facilities and system operation and maintenance, should be examined in detail, and the assessor should conduct a physical inspection of suspected facilities. During this examination, the assessor should note any atypical conditions, even if those conditions do not appear to definitively correlate with the total coliform- or *E. coli*-positive samples, and should review past Level 1 and Level 2 assessments and sanitary survey results.

The assessor should also consult with others involved in operation or management of the system to gather additional observations and insight as to possible causes for the trigger. This consultation would also help to identify whether there are multiple causes for the trigger and/or sources of contamination. Gathering information on all elements would also be useful in setting a baseline if another assessment is triggered in the future. This baseline information provides a good indication of where additional follow-up may be needed.

The Level 2 assessment should be conducted thoroughly to capture the possibility that there may be multiple causes for the coliform positive samples. Level 2 assessments should be conducted as quickly as possible after the system learns that it has triggered a Level 2 assessment (e.g., soon after notification of *E. coli* positive sample results). The assessor should go over and complete the entire assessment form, even if the apparent cause of the contamination has been identified and is understood, to ensure that he/she has a complete picture of the overall integrity of the system and does not inadvertently overlook a potential sanitary defect.

Once an assessment has been triggered, system personnel may become very busy performing the investigation, answering questions and responding to the public. **Therefore, systems should prepare for a possible assessment by developing some standard datasets based on operational data for items such as disinfectant residuals, treatment process variables and field sampling results.** Much of this data can typically be found in monthly operating reports and other summaries that are submitted to the state. These datasets should be continuously updated so that they are ready to be used immediately upon triggering an assessment. For further discussion on operational data, see **Section 4.5.2.1** of this document.

4.5.1. Assessing samples, sampling sites and sampling protocols

This section of the assessment is designed to determine whether water samples could have been contaminated during the sample collection or processing, resulting in total coliform- or *E. coli*-positive samples. In that case, the positive results may not indicate a distribution system problem but rather a sampling problem. Several references are available to provide detailed guidance on sampling (AWWA 2008; APHA et al. 2005; USEPA 2001a; USEPA 2006c; USEPA 2006d).

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. This part of the assessment should include a field visit to inspect the sample location(s) or a detailed discussion with the sample collector to determine the conditions at the sample site(s).

> 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.

Some of the **common items the assessor should evaluate at the sample site(s)** include:

- Cleanliness and suitability of the sample tap and 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.

In addition to sample tap contamination, it is possible that elements of the sampling protocol that were not followed closely could result in contamination of the sample. **Elements of the sampling protocol** that systems should follow may include:

- Removal of the tap aerator,
- Adequate flushing of the tap prior to sample collection,
- Proper storage and preparation of the sampling container,
- Correct sample collection technique, including items such as elimination of splashing water from sink and the sampler touching the inside of the sample bottle,
- Correct storage, preservation and handling of sample(s) during transport to laboratory, including items such as cleanliness of coolers and use of watertight bottles during transport (to prevent leakage), and
- Compliance with holding time and temperature requirements, including items such as maintenance of ice packs.

Finally, this evaluation should include a discussion with the laboratory to determine if all laboratory quality checks were performed with satisfactory results.

4.5.2. Assessing the distribution system area near the positive samples

Once the evaluation of the sample site(s) has been completed, the assessor should proceed to 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.

A Level 2 assessment of the distribution system should include the collection and review of available data. The data to be reviewed should include **operational data** (e.g., pressures, flows), **water quality** (e.g., pH, turbidity, etc.) and **information on the physical condition of distribution system components** (see **Sections 4.5.2.1** to **4.5.2.5** of this document). A Level 2 assessment would warrant a detailed investigation of the components, particularly those near a cluster of positive sample locations. This detailed investigation would warrant site visits and possibly hiring expert assistance for inspections, particularly for storage tanks that might require specialty equipment and confined space entry safety measures. The Level 2 assessment form (see an example form in **Appendix B** of this document) provides a list of questions that should be answered as part of a Level 2 assessment. The questions in the form provide an indication of the level of detail that should be included for each component evaluation.

The area of the distribution system that the assessor should evaluate depends on the system configuration along with the extent of coliform positive samples. Smaller systems will likely have fewer distribution system components and therefore a lesser level of effort in completing the assessment. For larger systems, the assessor may focus the 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.

4.5.2.1. Operational data

The operational data review should include collection, compilation and analysis of the system data from a variety of sources to get a more complete understanding of the system conditions and events that may have occurred prior to triggering an assessment. The data collected should include recent data as well as historical trends to provide a basis for comparison to determine if atypical events such as main breaks or system component failures have occurred.

The **operational data elements** should be reviewed during all Level 2 assessments, although the available data and accessibility of electronic data may vary by water system size and type.

Larger systems may have electronic databases from which to extract pertinent information including:

- Distribution system and treatment plant process data from SCADA systems for pumping, storage and pressure data,
- Water quality measurements from LIMS or external laboratory reporting systems,
- Customer complaint and water usage data from CSIS,
- Data on operations and repairs in the distribution system from MMIS,
- Recent and historical information from main break databases,
- Pipe material and condition information from asset management databases,
- Hydrant testing and fire-fighting from fire department information, and
- Activities performed from operations logs.

For smaller systems, much of the data sources listed above may not be electronic and would thus involve additional effort by the system to compile the data as part of the assessment. EPA therefore encourages these types of systems to maintain records of the above-mentioned data elements to help the assessor quickly conduct an assessment, should they be triggered to do one.

The operational data review can provide an indication of the elements of the assessment on which to focus efforts. For example, if the SCADA data indicates some low-pressure readings in a particular area of the distribution system, follow-up investigations could focus on that area. However, the assessor should not ignore other areas of the distribution system, as microbial contamination can be a result of multiple causes.

Tables and graphs summarizing the data and findings could be helpful supplemental items to prepare and submit to the state, if systems are asked or required to do so. Although systems, under the federal regulations, are not required to submit the collected data and supplemental analysis with the assessment form, EPA recommends that these items be kept on file for future reference in case another assessment is triggered. States may also require the system to submit such data and analysis or may want to look at this information during their review of the assessment forms or during a sanitary survey.

4.5.2.2. Water quality data

As part of any assessment, water quality data should be compiled and evaluated. This data would include parameters collected in the distribution system and at the source or treatment plant (discussed further in **Section 4.5.3** of this document). The parameters to be evaluated will likely vary by system type, treatment process used and other operational practices but may include the items outlined in **Table 4-2**. Systems that do not currently collect water quality data at one of the locations suggested in **Table 4-2**, might consider doing so in order to create a baseline for comparison should another assessment be triggered in the future.

The assessor may find it appropriate to collect special purpose samples of total coliforms (and potential subsequent *E. coli*) analysis and monitor additional water quality parameters such as disinfectant residual. An example of a special purpose sample is one taken to determine whether disinfection practices are sufficient following pipe placement, replacement or repair. Records of any special purpose samples taken should be kept for comparison should another assessment be triggered in the future. Take note that special purpose samples, such as those taken during an assessment, must not be counted towards compliance (i.e., they should not be included in determining whether an assessment has been triggered).

Table 4-2: Typical Water Quality Data to Be Evaluated During an Assessment

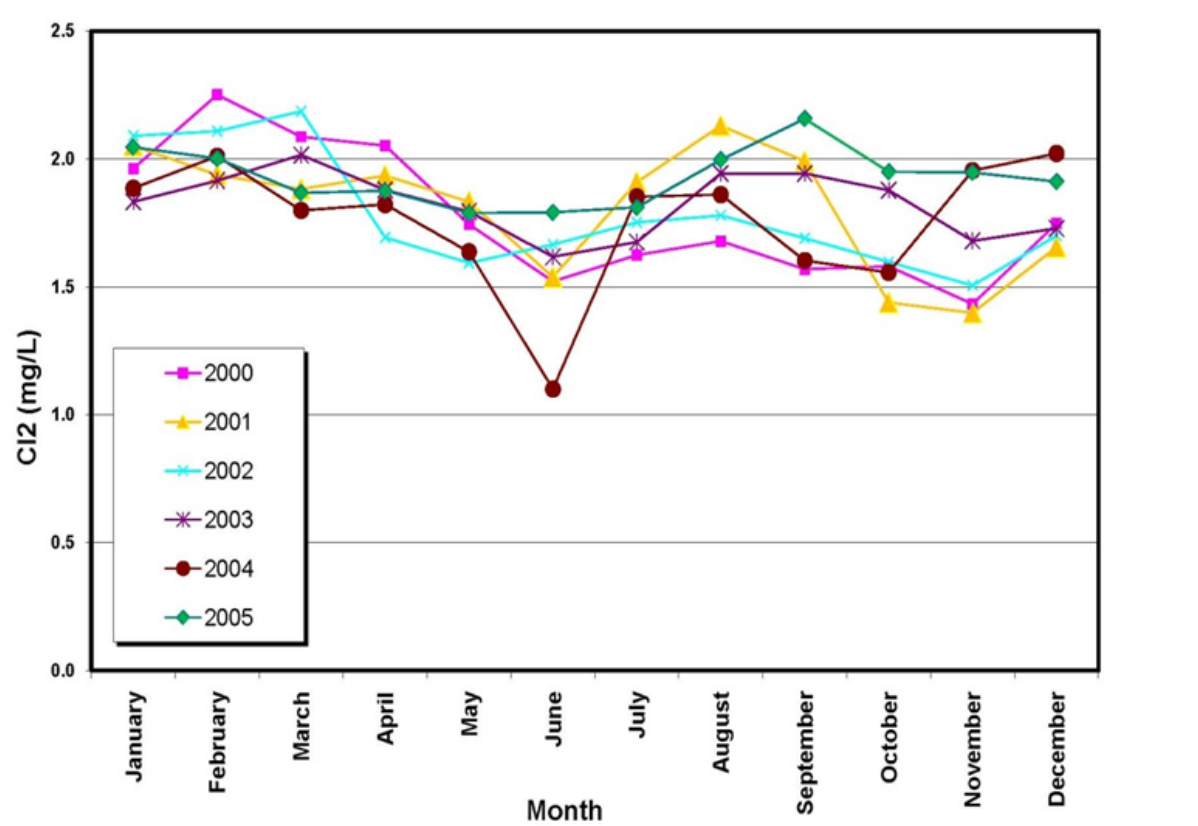
Water Quality Parameter	Location of Sample Collection
Disinfectant residual concentration	Throughout the distribution system, including total coliform sampling sites
	At storage tanks throughout the distribution system
	At the entrance to the distribution system at each source
DBPs	At approved monitoring locations in the distribution system
Total coliforms and *E. coli*	All distribution system sampling sites, including those for repeat, additional routine and special purpose samples (like those associated with recent main installation or repair)
	Entrance to the distribution system at each source
HPC	All distribution system sampling sites for total coliforms
Nitrite and nitrate (systems using chloramine)	Distribution system sites with low disinfectant residual

Once the water quality and operational data have been collected, they should be analyzed to determine if any atypical events or measured values have occurred. Depending on the data that

are available, there may be several ways to examine the data. One good method is to develop a **historical trend** for monitoring results and individual parameters at each sampling location. Spreadsheet and graphing software can be helpful in developing and reviewing historic trends. The historical time series can be evaluated visually to determine if there are differences between current results (under assessment) and historical trends.

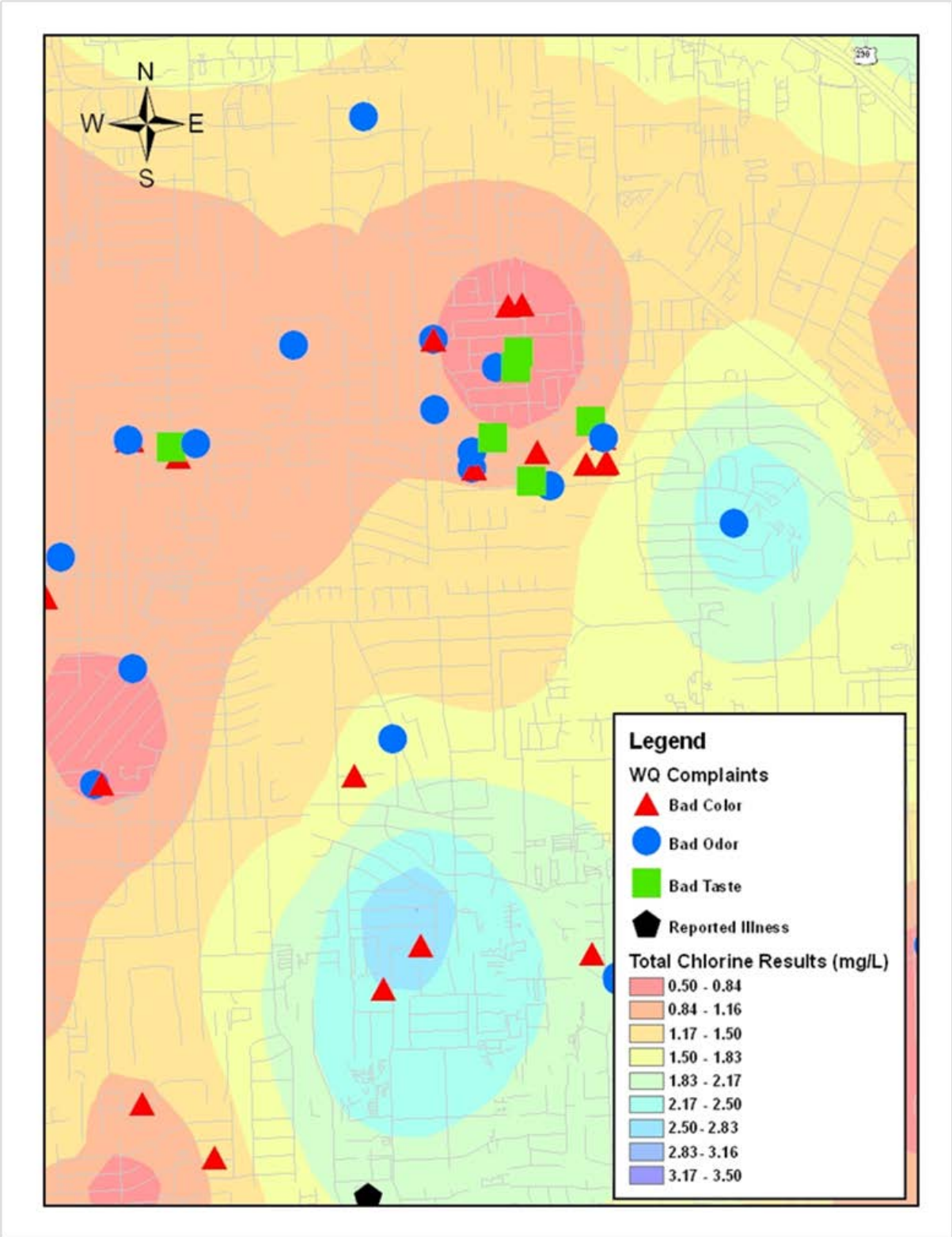
Figure 4-2 provides an example of a historical time series graph of total chlorine measurements from distribution system samples using Microsoft Excel software. The average total chlorine concentration for each month is plotted for multiple years. This type of graph can help to identify if measured values are within normal ranges or might represent an atypical condition within the distribution system. Similar graphs could be constructed for minimum and maximum residual disinfectant measurements, total coliform-positive samples and related water quality sampling data.

Figure 4-2: Example Time Series Graph for Distribution System Chlorine Results



A **spatial analysis of data** can also help to identify problem areas. Mapping of water quality results can be done using a paper map or GIS software (see example in **Figure 4-3**). The correlation between different water quality variables (e.g., disinfectant residual and total coliforms) can be more apparent when the data is viewed in a spatial analysis. The results of a spatial data analysis can be used to focus the Level 2 assessment activities on the appropriate areas and components of the distribution system.

Figure 4-3: Example of Spatial Analysis of Disinfectant Residual and Customer Complaint Data



Consideration of flow pathways or use of a hydraulic model can also help determine if a specific activity could be related to the coliform-positive samples at a given location. This type of analysis can be useful in finding the source of contamination, particularly if several positive samples fall within the influence zone of a specific distribution system pump station or tank. In this instance, the assessor can focus attention on specific locations at the distribution system in determining the cause of the positive samples. However, as mentioned previously, other areas of the distribution system should not be ignored, because the contamination can be a result of multiple causes.

The assessor might also want to review and consider **supplemental data** sources beyond water quality measurements in the assessment. For example, customer complaints might show an increase in a particular area of the distribution system that could be correlated to distribution system problems as shown in **Figure 4-3** where the correlation between the level of disinfectant residual and the location of customer complaints are plotted.

4.5.2.3. Operational activities and unusual events

Along with water quality measurements, it is important to understand the extent of activities occurring in the water system that may have resulted in total coliform-positive samples. **Compilation of operational activity data** may require the assessor to consult with different departments within the water system and with external agencies. The types of activities and events to compile and review would include those that might result in distribution system contamination, including:

- Pipe breaks and associated repairs,
- Events resulting in a loss of pressure (e.g., power failures),
- Flushing and hydrant testing,
- Construction activity that impacts water pipes,
- Unusually high (or low) demands that might alter typical flow patterns, including temporary connections for construction and firefighting,
- Break-ins and vandalism at system facilities,
- Treatment process upsets,
- Weather events, and
- Source water changes.

Once a list of distribution system activities and events has been compiled, the assessor can compare this list to historical records to determine if any activities or events could have led to the distribution system contamination. Any suspect operational activities or events should be further investigated and documented on the assessment form.

Public health officials also track reported illnesses, doctor visits and purchase of over-the-counter medicines. These public health data sources might be helpful to the assessor in understanding the potential source and extent of contamination. Systems should work to develop relationships with their local public health officials so that if an assessment needs to be conducted, health information can be more readily accessible.

Appendix C of this document includes an example of an assessment where the suspected cause of the contamination was inadequate chlorination of an in-line conditioner after repair work was done on the pump and the plumbing around it. The in-line conditioner was chlorinated afterwards and put back into service.

4.5.2.4. Assessing distribution system components

The objective of this evaluation is to help determine if a particular distribution system component has a sanitary defect that would require correction or if distribution system events could have contributed to the positive coliform samples. From the operational data review, the assessor should have compiled data to indicate what activities had been occurring in the distribution system near the location of the total coliform-positive samples, including operational changes, maintenance and atypical events. Under this step of the assessment, the assessor might ask that the system obtain further detail for any location or event that might be significant. The system could collect additional data to help define the extent of the contamination and to determine whether the contamination has spread.

The assessor should focus first on the area of the distribution system closest to the positive coliform samples. Operator knowledge or the results of a flow path analysis or hydraulic model can be used to determine the area(s) likely to be associated with a given sample site. For example, if the positive sample is located within a defined pressure zone, the entry point to the zone and related facilities in the immediate area should be assessed first before continuing the assessment in other areas of the distribution system, progressing from closer areas to areas farther from the positive coliform samples.

The assessor should evaluate distribution system facilities to determine whether the infrastructure and equipment are operational and in good repair. The evaluation should include elements such as those presented in **Table 4-3**. The items in **Table 4-3** are not intended to be an exhaustive or binding list but rather a summary of typical distribution system components to help focus the assessment on the existing water system configuration. Depending on the system configuration, not all elements would be present in all systems.

A Level 2 assessment of water system components should include a review of data and information that indicates the latest observed condition of the component, its condition at its last

inspection date, observations from recent visits by operations staff and other related data such as disinfectant residual that might assist in focusing the assessment efforts. This would include any previously noted sanitary defects or significant deficiencies and records on how these were addressed. An on-site inspection of the component by the assessor should be completed to verify its current condition.

Table 4-3: Typical Items to Evaluate in Distribution System Assessment

Component	Typical Items to Evaluate
Pump stations	Proper operation of pumps and valves
	Recent losses of power
	Recent losses of pressure
	Proper operation of surge control appurtenances
Distribution system pressure	Maintenance of adequate pressure
Air-relief / Air-vacuum valves	Proper operation of valves
	Valve vault free of standing water and debris
Fire hydrants	Proper operation of shut-off valves
	Leaks at connection to lateral piping
Flushing assemblies / Blow-offs	Proper operation of valves
	Leaks at connection to piping
Pipes	Recent main breaks
	Recent leaks
	Recent installation of new mains or construction activity
Distribution system isolation valves	Recent operation resulting in breakage

4.5.2.5. Assessing storage facilities

Storage facilities, or tanks, have been linked to microbial contamination events and therefore are an important component to assess when responding to positive coliform samples (Clark et al. 1996). Microbial contamination can enter storage facilities either through system water or external tank breaches. If contamination is introduced through system water (i.e., transported to the storage facility from a different contamination site), microbes can remain viable and possibly multiply within the tank water and sediments.

Table 4-4 outlines some of the typical storage facility items that should be evaluated during an assessment. The items in **Table 4-4** are not intended to be an exhaustive or binding list but rather a summary of typical storage facility components to help focus the assessment on the existing water system configuration. Depending on system configuration, not all items would be present in all systems.

The assessment should initially focus on the storage facilities that supply the area near the total coliform-positive samples, with evaluation of other more remote facilities as a next step. Review of recent tank inspection reports, operator interviews and examination of historical disinfectant residual data for the tank and its vicinity may also provide the assessor with valuable information for the assessment. The assessor might ask the system to collect additional samples for residual and/or total coliform analysis or suggest a more complete inspection of the storage facility by a qualified party such as a professional cleaning and inspection company.

For systems with hydropneumatic tanks and/or bladder tanks, these tanks should be maintained and inspected according to manufacturer recommendations. A Level 2 assessment should include review and inspection of maintenance records for these types of tanks.

Table 4-4: Typical Items to Evaluate at Storage Facilities

Storage Tank Element	Typical Items to Evaluate
Access hatches	Signs of vandalism or forced entry
	Ability of hatch to seal tightly when closed
	Rust, holes or other breaches
Vents	Signs of vandalism or forced entry
	Absence of screen; holes or other breaches in screens
	Rust, holes or other breaches in vent piping and penetration through tank wall
Overflow piping	Rust, holes or other breaches in piping and penetration through tank wall
	Absence of screen; holes or other breaches in screens
Control valves	Correct operation of level control valves, altitude valves and related appurtenances
Tank exterior	Signs of deterioration, rust or other breaches
Tank interior	Integrity of lining material
	Presence and extent of floating material and sediment within tank; existence of microbes within sediment
	Presence of dead animals
Disinfectant residual	Level of disinfectant in tank, ideally at different tank levels

4.5.3. Assessing the treatment facilities

For a PWS operating a treatment plant, even if the only treatment is a chlorinator at a well, assessment of the proper operation of the treatment process is important to determine if a plant upset could be the source of the microbial contamination resulting in positive coliform samples. For most treatment facilities, regulatory data collected for compliance with related treatment requirements (e.g., SWTR, GWR) should be available. A review of this data may indicate a potential treatment plant problem that could have allowed microbial contaminants to enter the distribution system.

As part of a Level 2 assessment, the assessor should review the treatment process data. When reviewing the treatment data, he/she should pay particular attention to disinfection processes and turbidity removal, as these processes are responsible for the majority of microbial inactivation (Letterman et al. 1999). For disinfection processes, the disinfectant feed systems and resulting disinfectant concentration should be evaluated to ensure that proper dosing has taken place and desired residuals are maintained. For turbidity removal, the coagulation/sedimentation and filtration processes should be evaluated to ensure that microbial contaminants could not have entered the distribution system along with a spike in turbidity. Power outages and other events that disrupt normal operations should also be considered if review of operational data shows that they have occurred.

Table 4-5 provides an overview of the types of data elements that should be reviewed as part of a Level 2 assessment. The items in **Table 4-5** are not intended to be an exhaustive or binding list but rather a summary of typical treatment facility components to help assessors think about the system configuration. Depending on system configuration, not all elements would be present in all systems.

Table 4-5: Typical Treatment Facility Elements to Evaluate

Treatment Facility Element	Typical Items to Evaluate
Equipment (pumps, mixing units, settling units, pipes, valves, chemical feed units, filters)	Status of equipment – operational and maintained in accordance with the treatment plant Operation and Maintenance procedures
	Recent installations or repairs
Treatment Process	Introduction of new sources or changes in the source water
	Recent changes in the treatment process
	Interruptions in treatment – lapses in chemical feed or proper mixing
	Turbidity measurements at all appropriate locations in the treatment process (source, settled water, pre- and post-filtration, finished water, etc.)
	Disinfectant residual measurements and C x T (concentration x time) calculations
	Flow rates at each plant process

4.5.4. Assessing the source water

To wrap up a Level 2 assessment that began with the sample site and worked backward through the distribution system to the treatment plant, the final component for evaluation would be the source water. The source water can include wells, springs and surface water bodies (see **Sections 4.5.4.1** to **4.5.4.3** of this document). Changes in source water, extreme weather events and introduction of new sources can all be possible causes of microbial contamination. The source water should be evaluated using historical data and system records to determine if the source water has contributed to the coliform positive samples. For a Level 2 assessment, site visits and additional source water monitoring would likely be appropriate.

4.5.4.1. Wells

For systems served by a well (or wells), the assessment should verify the integrity of the well and proper operation of the well system to ensure that contamination could not have entered the distribution system from the well. The assessor should pay particular attention to potential pathways that would allow the entrance of surface water, soil, animals or other foreign matter into the well. The well should also be constructed to prevent the accumulation of surface water around the wellhead and prevent inundation during periods of flooding or increased runoff. Well inspection records and operation and maintenance records should be reviewed and weather

events should be considered if runoff could have affected the well. **Table 4-6** outlines some typical items to evaluate for wells. The items in **Table 4-6** are not intended to be an exhaustive or binding list but rather a summary of typical well components to help systems and the assessor think about the system configuration. Some elements may not be present depending on the design/configuration of the well and the type of pump in the well.

Table 4-6: Typical Items to Evaluate at Wells

Well Element	Typical Items to Evaluate
Well house / enclosure	Signs of vandalism or forced entry
	Unsanitary conditions like the presence of rodents or other animals
Well cap / Well seal	Tightness of well cap and seals, presence of gaps or openings
Well vent	Vent properly screened, angled to be self-draining and has sufficient height above ground
Well casing	Holes, breaks, corrosion or deformation in casing and welds
Annular grout seal	Missing, sunken, bridged or channeled grout surrounding the well casing
Pump and pump assembly	Attached to casing with no unprotected openings and has watertight seal
Pitless adapter	Integrity of pitless adapter connection
Inundation	Signs of inundation by floodwater or runoff; depressions around wellhead

Appendix C of this document provides an example of an assessment where well contamination was the likely cause of positive coliform samples. In this case, the well was found to have unsanitary conditions, possibly due to recent flooding and a corroded casing.

4.5.4.2. Springs

For systems served by a spring (or springs), the assessment should verify the sanitary condition and proper operation of the spring and associated piping. Typical items the assessor should evaluate for a spring source include:

- Condition of the spring development,
- Impacts from surface water runoff and weather conditions,
- The physical condition of the spring box,
- Impacts from vandalism or forced entry to determine if holes or other breaches could have occurred that would allow for the introduction of microbial contaminants,

- Signs of inundation, including deposits of soil or soil erosion, and
- Signs of small animals, slugs, bugs, etc., in the spring box.

4.5.4.3. Surface water

Surface water sources can be impacted by extreme weather events that can influence the influent water quality to the treatment plant. Atypical events may impede the ability of the treatment process to perform as desired and may allow for the introduction of microbial contaminants into the distribution system. Heavy rainfall and rapid snowmelt can carry large soil loads into surface water sources, thereby increasing turbidity and baseline microbial contaminant concentrations. Similarly, flooding can alter the raw water quality and require treatment changes to achieve good finished water quality.

For systems that have multiple surface water sources, a change from one source to another could trigger a treatment upset that might result in microbial contamination entering the distribution system. In performing the Level 2 assessment, systems should obtain source water data and review it with the assessor to determine if atypical surface water quality could have impacted the treatment process.

4.5.5. Additional considerations

EPA recognizes that the process of conducting a Level 2 assessment presented in the preceding sections may not necessarily apply to all types of systems. Because of the complexity and the diversity of the different configurations of PWSs, a one-size-fits-all approach will not be appropriate for all systems. Larger systems will more than likely have all the elements mentioned in the preceding sections while smaller systems may only have some of them. For example, some small ground water systems may only have a well, provide no treatment and have a limited distribution system consisting only of premise plumbing. The process of performing a Level 2 assessment will therefore vary from system to system. This section presents additional considerations systems may want to incorporate in their assessment protocol depending on their system type.

4.5.5.1. Systems with limited or no distribution system

For small systems, it might be the case that they do not have any treatment process or an extensive distribution system. In this case, the Level 2 assessment will only focus on those elements that are present in the system such as the source water (e.g., wells) and the limited distribution system.

For NCWSs that have their own source water and do not supply water beyond their premises (typical examples are schools and churches), then an assessment of the pipes inside the building (what is typically considered premise plumbing) is required. Typically in a CWS, premise plumbing is beyond the control of the PWS. However, in the case of NCWSs, the premise plumbing may be part of the system and if so, must also be included as part of the assessment. One thing the assessor will look for is the presence of cross connections. The majority of backflow events resulting from unprotected cross connection occur in premise plumbing (USEPA 2001b).

In cases where the results of total coliform monitoring also triggered the GWR requirements in addition to triggering an assessment under the RTCR, it might be possible to combine the assessments required under both rules into one assessment, as long as the combined assessment complies with the requirements of both rules. Systems should check with their states before performing such assessment. See also **Chapter 6** of this document regarding the overlap between an assessment under the RTCR and a sanitary survey.

4.5.5.2. Large systems

Large systems may want to determine whether the contamination is widespread or localized in the distribution system. If the total coliform-positive samples that triggered the assessment are clustered in one part of the system, the assessment could be targeted to specific sections of the distribution system or facilities if appropriate. It may not be practical or necessary to conduct an assessment of the entire distribution system. Looking at historical data may also help determine if the problem is episodic or chronic. Knowing so would help determine the type of corrective action to take to address the problem.

4.5.5.3. Wholesale and consecutive systems

For PWSs that purchase water from another system, also known as consecutive systems, the source water can be considered to be the connection(s) from the wholesale (seller) system. During a Level 2 assessment, a review of the records related to the connection (e.g., flows, pressures, water quality parameters if measured) should be performed.

It is also recommended that the consecutive PWS contact the wholesale system to coordinate assessment efforts. The possibility exists that a contamination event occurred in the wholesale system upstream of the connection and that the contamination has migrated to the consecutive system. While the wholesale system would not be required to perform a Level 2 assessment in this case (unless it also exceeded the trigger level), it may be required to conduct source water monitoring under the GWR and may want to voluntarily investigate its system along with the assessment being performed on the consecutive system. Water quality data from

the wholesale system at or near the connection point for the consecutive system may also prove to be valuable in the Level 2 assessment.

Similarly, if a wholesale system experiences a total coliform trigger, it should notify its consecutive system(s) if the contamination could have spread to the consecutive system area. Additional samples and data from the consecutive system may help define the extent of contamination in the wholesale system and identify potential problems and sanitary defects.

Consecutive systems may or may not have additional sources and treatment facilities, such as their own wells with treatment or booster chlorination of purchased water. These complicating factors should be considered during the assessment as needed. If additional sources are present, they should be evaluated as described in **Section 4.5.4** of this document, depending on the location of the positive distribution system samples and what areas of the distribution system are fed by which source. If treatment facilities are present, they should be evaluated as described in **Section 4.5.3** of this document. Furthermore, the samples, sampling sites, sampling protocols and distribution system area should be evaluated as described in **Sections 4.5.1** and **4.5.2** of this document.

4.6. What is the timeline for completing the Level 2 assessment?

A Level 2 assessment must be completed as soon as practical after the determination that a trigger has been exceeded. Systems must then submit the completed assessment form to their states for review within 30 days after learning that they trigger an assessment. See 40 CFR 141.859(b)(4). The 30-day timeframe allows for sufficient time for problem identification and potential remediation of the problem in conjunction with the follow-up assessment, in most cases.

> Systems must conduct the assessment as soon as practical after learning that they have triggered an assessment. They have **30 days** from the time they triggered the assessment to complete the assessment (and necessary corrective actions, if possible) and submit the assessment form to the state (with the timetable to complete any remaining necessary corrective actions not completed when the assessment form is submitted).

If the state determines that the assessment is insufficient, the state must consult with the system. Assessments may be considered insufficient if they are not fully executed (e.g., the conditions at the well were not fully assessed) or if the assessment was incomplete (e.g., not all of the required elements were examined). If necessary after consultation, the system must submit a revised assessment form to the state on an agreed-upon schedule not to exceed 30 days from the date of the consultation. See 40 CFR 141.859(b)(4) and 141.859(d).

For corrective actions not completed by the time of submission of the assessment form (e.g., in the case where parts need to be ordered and may take longer than 30 days to be delivered and installed), the system must complete the corrective action(s) in compliance with a schedule determined by the state in consultation with the system. To facilitate the discussion during the consultation, the system may propose a schedule for the corrective action(s). The system must notify the state when each scheduled corrective action is completed. See 40 CFR 141.859(c) and 141.859(d).

5. Corrective Action

5.1. What is the RTCR's requirement regarding corrective action?

A corrective action is required when a PWS has triggered a Level 1 or Level 2 assessment because of total coliform and/or *E. coli* positive samples AND that assessment has identified a sanitary defect that could have caused the contamination (40 CFR 141.859(c)). It is also possible that no sanitary defect will be identified during a Level 1 or Level 2 assessment and if so, no corrective action will be required (see **Section 2.6** of this document in instances where no sanitary defect is identified) (40 CFR 141.859(b)(3)(i) and 141.859(b)(4)(i)). However, the state may recommend or require that the system take some sort of action (e.g., temporary disinfection) to make sure that the contamination is addressed even in the absence of an identified sanitary defect. See **Section 5.3** of this document for some of the best practices systems can take following a coliform detection or an assessment trigger.

PWSs are required to correct any sanitary defect found during an assessment.

The PWS should also consult with the state as necessary to complete corrective actions that the state will consider to be sufficient. The state may also initiate this consultation. This consultation should begin with the Level 1 or Level 2 assessment, which should outline the investigation that the system performed or will perform and the proposed actions to correct the problems that were identified. The system must submit a Level 1 or Level 2 assessment form to the state within 30 days after learning that it exceeded the trigger. The form must describe the sanitary defects detected (if any), the corrective actions completed and a proposed timetable for completing the corrective actions not already completed. A consultation with the state as early as possible in the assessment and corrective action phase will allow the system and the state to discuss all relevant information and appropriate timeframes to meet the rule requirements. See 40 CFR 141.859(d).

5.2. What corrective actions can PWSs take?

The type of corrective action that a system performs will depend on the cause of the contamination that it identified that resulted in a trigger for a Level 1 or Level 2 assessment.

Total coliform and *E. coli* positive samples can result from a variety of causes. Once the system has identified those causes through the assessment process, the system will need to make corrective actions to restore the integrity of the distribution system.

Discussions and informal surveys with states and systems[9] have identified the following as some of the common causes of total coliforms and *E. coli* detections in the distribution system, a number of which are interrelated:

- Failure to disinfect (or improper disinfection) after maintenance work on the distribution system,
- Main breaks, especially in certain vulnerable locations such as under a stream or high groundwater level,
- Holes in storage tank, inadequate screening and other defects which could allow animals and/or fecal matter to enter the tank,
- Loss of system pressure (sometimes associated with main breaks or loss of power),
- Lack of regular flushing programs,
- Biofilm build-up in the distribution system, including biofilms at multiple locations or that move throughout system or those associated with seasonal changes and/or loss of disinfectant residual,
- Cross connections, especially at certain high-risk locations (e.g., hospitals, chemical plants, chemical holding/storage facilities, funeral homes, etc.),
- Inadequate disinfectant residuals,
- Contaminated sampling taps, and
- Sampling protocol errors.

The specific cause(s) of total coliforms and *E. coli* in the distribution system will likely differ from system to system. The Level 1 and Level 2 assessments are designed to help systems identify the specific causes so they can be appropriately addressed.

The results of the Level 1 or Level 2 assessment may indicate that the system should employ the suggested corrective actions, measures or installation of devices (discussed in **Sections 5.2.1** to **5.2.11** of this document) to address the identified issue; or, if the PWS has them already, improve their operation and use in their system.

Table 5-1 describes some general actions that systems can take in response to the common causes of total coliform or *E. coli* positive samples that resulted in the RTCR trigger, including additional sources of information for correcting the problem. Some actions can be performed in response to multiple types of causes and multiple actions may be needed in response to a single identified cause. Most of the corrective actions listed in **Table 5-1** are described in more detail from **Section 5.2.1** through **Section 5.2.11** of this document, along with

[9] Informal surveys of their constituents were conducted from February to March 2010 by the American Water Works Association (AWWA), the Association of Metropolitan Water Agencies (AMWA) and the Association of State Drinking Water Agencies (ASDWA) to determine the common causes of coliform-positive results in the distribution system and the types of corrective actions taken in response to those positive results.

examples that can help mitigate or eliminate the sources of coliform contamination. **Table 5-2** summarizes these actions along with the general purpose for taking such actions.

Corrective actions should be completed in accordance with state guidance and industry best practices. States often have guidance for design, construction, operation and maintenance of water systems. Emergency response planning and implementation of cross connection control programs are also described in state guidance in some locations. An example of state guidance is the *Recommended Standards for Water Works,* also known as the *10 States Standards* (Great Lakes et al. 2007). In addition, drinking water system components installed as part of a corrective action should be in compliance with National Science Foundation (NSF)/American National Standards Institute (ANSI) Standard 61 and other applicable standards. NSF/ANSI Standard 61 addresses drinking water system components that are in contact with finished drinking water and whether contaminants leach or migrate from the product/material into the drinking water at levels that are above acceptable levels in finished waters. For smaller non-community water systems that include premise plumbing, corrective actions should also be in compliance with local plumbing codes.

In addition, **Appendix D** contains a listing of industry standards (e.g., American Water Works Association (AWWA) Standards), manuals and other reference materials that describe best practices and product specifications. Following these standards can help systems to ensure that a product (e.g., pipes, fittings, meters, etc.) or a process (e.g., main flushing, main installation, etc.) will provide satisfactory service. These standards can be valuable resources in implementing corrective actions.

Table 5-1: Common Causes of Total Coliforms and *E. coli* in the Distribution System and Possible Corrective Actions to Address Them

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Biofilms	• Taste and odor complaints • Colored or turbid water that takes a long time to clear • Elevated HPC bacteria levels • Numerous isolates with similar genotypic profile	• Conduct unidirectional flushing to remove biofilm and sediments from distribution system. • Maintain adequate pressure in system to prevent sloughing of biofilm by installing booster pump stations, variable frequency drives (VFDs), elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control. • Replace/rehabilitate pipe where biofilm sloughing is occurring. • Maintain disinfectant residuals in the distribution system. • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Manage water age by looping dead ends; increasing volume turnover; and/or installing appropriate main sizes, automated flushing devices or mixing devices.	• Water Research Foundation, *Strategies for Managing Total Coliform and E. coli in Distribution Systems*, 2009. • Water Research Foundation, *Factors Limiting Microbial Growth in Distribution Systems: Laboratory and Pilot Scale Experiments*, 1996. • Water Research Foundation, *Assessing and Controlling Regrowth in Distribution Systems*, 1990. • Water Research Foundation, *Factors Affecting Microbial Growth in Model Distribution Systems*, 2000. • Camper, A. K. *et al*., "Effect of Distribution System Materials on Bacterial Regrowth." Journal AWWA, Vol. 95 Iss. 7, July 2003, Page(s) 107-121.

[10] Some of the causes of total coliforms and *E. coli* listed under this column may or may not necessarily be considered as a sanitary defect, based on what conditions the state considers as such. Whether the identified cause is considered a sanitary defect or not, the PWS should address it to prevent future occurrence of contamination.

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Contamination of water during main installation, repair or rehabilitation	• Break/repair activities that could have allowed entry of contaminants or dislodged accumulated pipe debris into bulk water • Pressure loss associated with break • Low disinfectant residual • Colored or turbid water	• Flush system (spot or routine). • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Review/enhance existing procedures for main installation, repair or rehabilitation procedures. • Maintain adequate pressure in the system by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control.	• AWWA C651 (Standard for Disinfecting Water Mains)
Cross-connections	• Pressure loss event within a portion of the distribution system • Total coliform-positive samples occur at high elevation and/or low pressure location(s) • Presence of a high-risk customer for backflow (e.g., industrial user)	• Eliminate cross-connection. • Implement cross-connection control and backflow prevention (CCCBFP) program. • Install backflow prevention assemblies and devices. • Flush system (spot or routine). • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Maintain adequate pressure in system to prevent backflow and backsiphonage by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control.	• Cross-Connection Control Manual, EPA 816-R-03-002, EPA, February 2003

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Errors in the sampling protocol (i.e., proper sampling protocols were not followed – e.g., tap was not flushed, aerator was not removed, etc.)	• Changes in sampler or protocol	• Review current protocol and if inadequate, identify alternate protocol. • Enhance training on site preparation, flushing protocols and sanitary sample collection and transport procedures. • Sanitize sample coolers and ice packs. Ensure that samples are shipped properly and securely (e.g., bottles do not tip or become contaminated during transport).	• Water Research Foundation, *Sample Collection Procedures and Locations for Bacterial Compliance Monitoring*, 2004 • Interactive Sampling Guide for Drinking Water System Operators CD (In English: EPA 816-C-06-001; in Spanish: EPA 816-C-06-003), available at: *http://www.epa.gov/ncepihom/*
Inadequacies of the sample site (e.g., unsanitary conditions, leaks and breaches, unprotected access, improper construction, improper location)	• Changes in sampling site use • Presence of unsanitary conditions at the sampling site	• Develop a sample siting plan that is representative of the water quality in the distribution system. • Install dedicated sampling taps. • Correct leaks or other site deficiencies and breaches. • Sanitize or replace sampling site.	• Water Research Foundation, *Sample Collection Procedures and Locations for Bacterial Compliance Monitoring*, 2004 • Interactive Sampling Guide for Drinking Water System Operators CD (In English: EPA 816-C-06-001; in Spanish: EPA 816-C-06-003), available at: *http://www.epa.gov/ncepihom/*

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Inadequate disinfectant residual levels in the distribution system	• Variable raw and/or treated water quality conditions • Inadequate disinfectant at entry point • Inadequate disinfectant at booster stations • Interruptions in disinfection processes • Increases in temperature that lead to accelerated disinfectant decay	• Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Manage water age by looping dead ends; increasing volume turnover; and/or installing appropriate main sizes, automated flushing devices or mixing devices. • Install/upgrade on-line water quality monitoring and control. • Flush system (spot or routine).	• AWWA G200 (Standard for Distribution Systems Operation and Management)
Intrusion through pipe leaks, pipeline fracture cracks, leaking joints, submerged air-vacuum/ air-release valves and deteriorating seals	• Pressure loss or reduction in a portion of the distribution system • Presence of leaks, cracks and other entry points • High groundwater table and/or presence of sewers near the susceptible water main • Numerous isolates with unique genotypic profile	• Repair/replace leaky component. • Maintain adequate pressure in system by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control.	• Water Research Foundation, *Verification and Control of Pressure Transients and Intrusion in Distribution Systems*, 2004.

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Pressure loss (can result from events such as flushing, main breaks, power outages, fires or improper operations and management (operations and maintenance (O&M) practices)	• Recent maintenance activities, main breaks, power outages, fires • Turbidity increase or fluctuations	• Flush distribution system (spot or routine). • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Improve O&M practices. • Maintain adequate pressure by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. • Install automatic pressure monitoring and control.	• AWWA C651 (Standard for Disinfecting Water Mains) • AWWA G200 (Standard for Distribution Systems Operation and Management)
Sediment build-up in storage tank or reservoir	• Increased disinfectant demands • Increase in turbidity, particularly in water samples collected when tank is draining • Elevated HPC in samples from tank or reservoir • Low disinfectant residual in samples from tank or reservoir	• Drain and flush tank or reservoir. • Shock chlorination of tank or reservoir in accordance with state guidelines.	• AWWA C652 (Disinfection of Water-Storage Facilities)

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Storage tank physical deficiencies like holes, inadequate screening, etc. (can allow entry of birds, animals, insects and other vectors that can fecally contaminate the water)	• Presence of physical deficiencies • Recent work on or near the tank • Recent vandalism, storm events or other events that could impact tank integrity	• Repair broken parts of storage tank like the vent and hatch. • Repair / install screens. • Install / improve security measures.	• AWWA C652 (Disinfection of Water-Storage Facilities)
Contamination during flushing/firefighting activities	• Turbidity increase or fluctuations • Color increase or fluctuations • Pressure fluctuations	• Ensure unidirectional flushing approach is used for flushing program and that water quality objectives (i.e., chlorine, turbidity and iron) are met prior to terminating flushing.	• Water Research Foundation, *Implementation and Optimization of Distribution Flushing Programs*, 1992 • Water Research Foundation, *Deterioration of Water Quality in Distribution Systems*, 1987 • Water Research Foundation, *Development of Distribution System Water Quality Optimization Plans*, 2005
Treatment breakthrough	• Variable raw and/or treated water quality conditions • Inadequate disinfectant at entry point • Elevated HPC bacteria levels occur throughout the distribution system	• Increase disinfectant residual. Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Flush system (spot or routine). • Assess performance of treatment processes and remedy cause of coliform breakthrough (e.g., replace filter, decrease particle loading, etc.).	• Small Systems Guide to Safe Drinking Water Act Regulations, EPA Number 816-R-03-017, EPA 2003: *http://www.epa.gov/nscep*

Sanitary Defects[10] / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Vandalism and/or unauthorized access to facilities	• Recent work or other events at a distribution system facility • Presence of broken or disabled security equipment	• Flush system (spot or routine). • Install / improve security measures (e.g., install a fence, lock buildings, install alarms and cameras) • Develop and implement an operations plan. • Develop SOPs. • Develop emergency response plan.	• AWWA G200 (Standard for Distribution Systems Operation and Management) • Water Research Foundation, *Distribution System Security Primer for Water Utilities*, 2005.

Table 5-2: List of Common Corrective Actions

Action	Purpose
Disinfection (Section 5.2.1)	Improve or maintain disinfectant residual in the distribution system.
Flushing (Section 5.2.2)	Keep system clean and free of sediment. Reduce disinfectant demand of pipe surfaces. Remove stagnant, untreated or contaminated water. Address water quality deterioration at dead-ends.
Replacement / Repair of Distribution System Components (Section 5.2.3) Valves Water mains Fittings Hydrants Meters Dedicated sample taps	Reduce potential sources / pathways of contamination from improper installation or material degradation.
Maintenance of Adequate Pressure (Section 5.2.4) Booster pumping stations VFDs Elevated storage facilities Surge relief valves Surge tanks	Minimize sudden changes in water velocity, which impact system pressure. Reduce risk of backflow and intrusion contamination resulting from low pressures. Reduce risk of hydraulic disturbances to pipe surface biofilm.
Maintenance of Appropriate Hydraulic Residence Time (Section 5.2.5) Looping dead ends Installing appropriate main sizes Automated flushing devices Storage facility modifications	Mitigate water quality problems associated with increased water age (e.g., higher DBP formation, reduced disinfectant residual, increased microbial activity, nitrification and taste-and-odor problems).
Maintenance of Storage Facility (Section 5.2.6) Inspecting / cleaning of tanks Lining of storage tanks Vent / hatch repair Tank repair	Remove contamination from birds and insects. Remove accumulated sediment. Protect against tank wall corrosion. Prevent entry of vectors (e.g., birds, etc.)
Implementation or Upgrade of a Cross Connection Control and Backflow Prevention Program (Section 5.2.7)	Prevent flow of non-potable substances into the distribution system.
Sampler Training (Section 5.2.8)	Reinforces proper sampling and sample handling procedures to obtain uncontaminated samples. Reduces errors in sampling results.

Addition or Upgrade of On-line Monitoring and Control (Section 5.2.9) Water quality monitoring & control Pressure monitoring & control	Automatically control and monitor disinfectant dosages and water quality parameters (other than total coliforms). Monitor pressure levels to identify physical problems in the system (e.g., pipe breaks, leaking valves, etc.).
Addition of Security Measures (Section 5.2.10)	Monitor potential locations for vandalism or security breaches that could lead to water contamination. Increase public confidence in protection of their drinking water.
Development and Implementation of an Operations Plan (Section 5.2.11) SOPs Sample siting plans Routine inspections Emergency response plan Appropriately qualified operators	Integrate all operations and maintenance functions to meet flow, pressure and water quality goals. Establish a routine distribution system sampling plan. Implement an inspection and maintenance program to reduce sanitary defects. Define an emergency response plan for the distribution system to reduce reaction time and minimize confusion in emergencies. Ensure around-the-clock responsiveness.

5.2.1. Disinfection

Many systems use disinfection (by applying either temporary disinfection, shock chlorination or booster disinfection) as a response to positive coliform results. It is also commonly used as a precautionary measure, especially when the cause of a positive coliform sample has not been identified, to help mitigate any potential contamination that could be present in the system. If the contamination requires a long-term solution, it may take time for the system to design and perform a corrective action. In the meantime, the system cannot serve the contaminated water to its customers. The state may require the system, as part of the corrective action, to apply chlorination until the contamination is eliminated or a corrective action is put in place. When temporary chlorination is applied in response to a coliform occurrence, the system should notify its state. Chlorination should be kept in place until the state has reviewed the situation and has determined if the contamination has been addressed and the temporary disinfection can be suspended or if the disinfection needs to be continued.

Temporary disinfection can be conducted at the point of entry to the distribution system or can be installed at a location in the distribution system to target a specific area. Depending on the extent of the problem revealed by the Level 1 or Level 2 assessment, system-wide or targeted disinfection (such as shock chlorination) may be an appropriate corrective action.

For non-disinfecting systems or those using free chlorine, temporary/additional disinfectant in the form of sodium hypochlorite (bleach) is often used because it is easier to install and operate than gaseous chlorination or other disinfection methods, particularly on a temporary basis. It is a low cost option that can provide some protection to a portion of a distribution system or across an entire pipe network. However, care should be used in the storage of hypochlorite as age and temperature have been shown to be associated with the conversion of hypochlorite to perchlorate (Stanford et al. 2009).

For non-disinfecting systems, before beginning disinfection, it is also important to know if there are water quality issues such as the presence of iron and manganese in the water that may react with the chlorine. If chlorination is going to be a long-term solution, the source water should be evaluated for DBP precursors and naturally occurring ammonia.

It is important to note that temporary disinfection is better suited to deal with a single event and is not intended to deal with a chronic problem like source water contamination. Systems using chloramine as a secondary disinfectant should carefully balance chlorine addition with ammonia to maintain the desired chlorine to ammonia ratio for optimal chloramine formation.

Booster disinfection facilities located throughout a distribution system can provide additional chemical treatment in the system. Booster disinfection can improve or maintain disinfectant residual levels in a distribution system. Prior to discharge into the distribution system, potable water from a treatment facility must have a certain disinfectant residual level to minimize microbial growth. These levels are defined by state and EPA regulations. Organics and reduced metals in the water also consume disinfectant residuals; therefore, it is vital to maintain an appropriate disinfectant residual level in the system in order to avoid increased levels of total coliforms in the system.

See **Chapter 6** of this document for a discussion of simultaneous compliance issues systems should consider when using disinfection as a corrective action.

5.2.2. Flushing

A water main flushing program helps to keep a system clean and free of sediment, can reduce the disinfectant demand of pipe surfaces and removes stagnant water and untreated or contaminated water that may have entered the system (Kirmeyer and Friedman 2000). Flushing can also be used to address water quality deterioration at dead-ends. The volume of water flushed is related to the length of flushing time and flow rate from the hydrant. Systems should flush until a disinfectant residual can be measured or some other water quality target is reached (other than just until the water appears clear). Systems could perform scheduled system-wide flushing

and/or periodic unscheduled (or "spot") flushing which can be used to address isolated water quality problems, including total coliform-positive samples. However, spot flushing should not be used as the only solution to positive coliform results or low residual events. Flushing should be used until the source of the problem and a more permanent fix have been identified.

Upon obtaining a positive coliform sample, a common response is to flush the area near the sample site to draw in fresh water and remove any contaminated water that may be present. This unscheduled spot flushing is different from a routine flushing program in that the flushing only occurs when triggered by a water quality measurement, customer complaint or similar event.

Minimum elements of a flushing scheduled/routine program are outlined in the AWWA G200 Standard (AWWA 2004) and involve: (1) a preventive approach to address local problems or customer concerns and routine flushing to avoid water quality problems; (2) use of an appropriate flushing velocity to address water quality concerns; and (3) written procedures for all elements of the flushing program including water quality monitoring, regulatory requirements and specific flushing procedures.

5.2.3. Replacement / Repair of distribution system components

Distribution system components and appurtenances such as pipes, valves, fittings, hydrants, meters and sample taps are integral parts of the water system. These components are also potential sources of contamination if improper installation or material degradation allows leaks or other entry points for contamination into a distribution system. **Inspection of distribution system components may indicate that they should be replaced or repaired as part of proper maintenance or detection during an assessment, whether or not it is identified as the cause of the leak or as a possible entry point for contamination (sanitary defect)** (see **Sections 5.2.3.1** to **5.2.3.6** of this document). Some components throughout the distribution system are located below grade, making a leak difficult to locate. However, a number of technologies have been developed to locate leaks below grade. **Systems should complete any repairs or replacements with proper attention to prevent contamination of the distribution system.** See the AWWA standards listed in **Appendix D** of this document for more information on installation, repair and replacement of distribution system components.

5.2.3.1. Water mains

The condition of distribution system piping can be vital to the quality of water being conveyed to a community. Contaminants may enter through holes, breaks, cracks or joints in the piping. The condition of a pipe can vary based on type, age and location of the pipe. Depending

on the condition of the pipe, the water main can be replaced or repaired to stop infiltration into the system.

5.2.3.2. Valves

Valves are located throughout a distribution system to isolate portions of the system as needed. Leaks at the connection points between the valve and the adjacent pipe, as well as a valve seat or valve body, can create a pathway for contamination.

5.2.3.3. Fittings

There are many types of fittings located throughout a distribution system. The most common type of distribution system fitting is a cross. A cross has four connections, which make it more susceptible to leaks. Leaks can occur because of a crack on the fitting or through the gasket between the fitting and another appurtenance, e.g., a valve, cap or pipe.

5.2.3.4. Hydrants

Hydrants are located throughout a distribution system to provide potable water at required fire flow pressures for emergency situations. Hydrant connections are tapped off the distribution system; therefore, these connections can be possible locations for coliform contamination to enter a distribution system. Replacing a damaged or faulty fire hydrant can help eliminate sources of contamination into the distribution system as it eliminates a pathway for contamination. Systems should attempt to control usage of the hydrants as much as possible to eliminate unauthorized use and install backflow prevention devices where possible.

5.2.3.5. Meters

Meters are located at entry points to commercial, residential and industrial facilities to measure the amount of water that is consumed at a particular location. Sizes for each of the meters will likely vary based on the type and usage requirements of a facility. Contamination may enter through the connection points of the meter and the distribution system. Replacing a broken or faulty meter can help prevent contamination of the distribution system through leaks, as it eliminates a pathway for contamination.

5.2.3.6. Dedicated sample taps

Typical sample locations often include both customer taps and dedicated sampling stations. A dedicated sampling station is a device that is plumbed directly into a distribution

system line to provide “improved access to the distribution system water and provide reproducible samples that are representative of water quality at the customer’s meter” (Kirmeyer and Friedman 2000). Installing dedicated sample taps can therefore minimize the occurrence of contamination that can result from improper sampling practices and minimize concerns about water quality in customer plumbing.

Dedicated sampling stations should be of metal construction, have unthreaded nozzles or a design approved by the state and be located so as to be representative of the water in the distribution system. If they are to be used for coliform sampling under the RTCR, they should be installed in locations in accordance with the system sample siting plan. They are typically covered to protect them from birds, insects, dirt and other sources of outside contamination. Freezing of dedicated sampling taps has occurred in northern climates and that possibility should be considered when deciding whether and how to install such taps and which types to install. Some manufacturers have dedicated sampling taps that resist freezing.

Additional guidance on selection of an appropriate sample tap, including factors such as type of tap and sink, can be found in Narasimhan et al. 2004.

5.2.4. Maintenance of adequate pressure

Pressure losses can occur in the distribution system as a result of events such as flushing, main breaks, power outages, service line breaks and fires. Pressure transients (also called pressure surges or water hammer) can occur when an abrupt change in water velocity occurs due to a sudden valve closure, pump shutdown or startup or loss of power. The resulting pressure wave, with alternating low and high pressures, travels back and forth through the distribution system until the pressure is stabilized. Low pressure conditions in the distribution system can allow a flow reversal or backflow of non-potable water to enter the system from a cross connection or other source such as intrusion. Pressure transients can also create hydraulic disturbances that allow biofilm material on pipe surfaces to enter the bulk water. Systems should check with their states regarding distribution system pressure requirements. Industry guidelines suggest that system pressure should be maintained within the range of 35 to 100 psi at all points in the distribution system (AWWA 1996). The AWWA G200 standard indicates that the minimum residual pressure at the service connection under all operating conditions should be greater than 20 psi (AWWA 2004). Many states also have guidelines regarding distribution system operating pressure. Written SOPs for pump, hydrant and valve operation under routine and emergency conditions can help minimize sudden changes in water velocity that impact system pressure.

Other actions that can help to maintain an adequate pressure in the distribution system include building new booster pump stations and elevated storage facilities, modifying existing

high services pumps and installing variable frequency drives (VFDs), surge relief valves and surge tanks (see the following discussion, **Sections 5.2.4.1** to **5.2.4.5** of this document).

5.2.4.1. Booster pumping stations

Booster pumping stations are used in the distribution systems to move water from lower pressure zones to higher pressure zones and to maintain pressure at desirable levels. As the water system grows and changes, existing booster pump stations may no longer be able to maintain the desired pressure across the distribution system. In such cases, the system may be required to construct a new booster station. The construction of a completely new booster pump station is not always required to maintain an appropriate pressure in a water system. There may be situations where a modification or replacement of an existing pump is sufficient.

5.2.4.2. Variable frequency drive (VFD)

A VFD, also called a variable speed drive, allows a booster pump to supply the required amount of flow based on system demand with a pressure set point to maintain constant system discharge pressure, controlled to within a few psi of an operator–adjustable system pressure set point. VFDs work with a system pressure transmitter to control the system pressure set point.

5.2.4.3. Elevated storage facilities

Elevated storage is provided within the distribution system to supply peak demand rates and equalize system pressures. In certain systems, elevated storage is more effective and economical than ground storage because by nature of its elevated location, pumping requirements may be reduced, and the storage can serve as a source of emergency supply since system pressure requirements can still be met temporarily when pumps are out of service. Elevated storage tanks are often cited in areas having the lowest system pressures during intervals of high water use. These areas are often those of greatest water demand or those farthest from pump stations. Elevated tanks are generally located at some distance from the pump station serving a distribution pressure level, but ideally are not placed outside of boundaries of the service area unless the facility can be located on a nearby hill. Elevated tanks are built on the highest available ground so as to minimize the required construction cost and the height requirements.

5.2.4.4. Surge relief valves

Surge relief valves provide pressure management by ejecting water out of a side orifice to prevent excessive high-pressure surges and can also be triggered to open on a downsurge in

pressure in anticipation of an upsurge to follow. Systems should always use surge relief valves with caution for they can make low-pressure conditions in a line worse than they would be without the valve.

5.2.4.5. Surge tanks

The four common types of surge tanks include pneumatic or closed tanks, open standpipes (or air chambers), one-way surge tanks (allows water to flow only from the tank into the pipeline) and two-way surge tanks (allows flow to and from the tank). If water is stored in these tanks for long periods of time, the water may lose its disinfectant residual and microbial growth and other water quality problems may result. Proper operations and maintenance of surge tanks is required to prevent poor quality or contaminated water from entering the distribution system.

Hydropneumatic tank systems are a popular way to provide pressure control and stabilization in smaller water distribution systems; however, they are not typically used in larger systems. A hydropneumatic tank system allows for fluctuations in water distribution system pressure and a potential cushion against water hammer. The system also minimizes booster pump on-off cycles so that a recommended frequency of 10-15 cycles per hour can be maintained.

The pressure tank uses a compressed air head-space to maintain system pressure. As water system demand increases, water in the pressure tank discharges into the system and reduces the pressure tank's water level, which expands the air cushion above the water and decreases the tank air pressure. When the air reaches a determined set point, the air compressor comes on to recharge the air space and cycles off when the high pressure set point is met. If the water demand continues to increase, the booster pumps will cycle on at the low water level and replenish the water level in the pressure tank. The pressure tank should be sized correctly, because its size determines the frequency of pump cycling.

5.2.5. Maintenance of appropriate water age, hydraulic residence time and mixing

Water quality problems associated with increased water age include reduced disinfectant residual, increased microbial activity, nitrification and/or taste and odor problems. As water travels through the distribution system, chlorine continues to react with natural organic matter (NOM) to form DBPs. Thus, increased water age can also lead to higher DBP concentrations. PWSs should develop an overall strategy to manage the water age in their distribution systems, while considering the need to have adequate storage for emergencies. Establishing a water age goal is system-specific depending on system design and operation, water demands and water quality (e.g., DBP formation potential). In the US, the average distribution system retention time is 1.3 days and the average maximum retention time is 3.0 days based on a survey of 800

medium and large water utilities (AWWA and AwwaRF 1992). Water age can be controlled through a variety of techniques including management of finished water storage facilities, looping of dead-ends and re-routing of water by changing valve settings (see the following discussion, **Sections 5.2.5.1** to **5.2.5.4** of this document). Additional guidance is provided in the AwwaRF report, *Managing Distribution System Retention Time to Improve Water Quality* (Brandt et al. 2004).

5.2.5.1. Looping dead-ends

Dead-end pipes often result in stagnant water conditions where water age increases, which can cause water quality problems. One of the solutions to address the stagnant water issue is looping of dead-ends. However, PWSs should carefully evaluate looping on a case-by-case basis as it may not actually reduce the long detention times present in those areas.

5.2.5.2. Installing appropriate main sizes

Most distribution systems have been designed to meet a minimum hydraulic capacity. Additional capacity is generally included at the design stage to accommodate for future growth or to allow more flexibility in the configuration of a distribution system network. A PWS may also have a policy to limit the number of different pipe diameters within the system in order to simplify construction and maintenance. Consequently, network pipes tend to be larger than is necessary to meet the daily demand from the network leading to increased retention time. Hence, there can be an option to replace mains with smaller diameter pipes but still maintain the required hydraulic capacity.

5.2.5.3. Installing automated flushing devices

Automated flushing devices are used to purge accumulated sediments at low spots and dead-ends of pipelines at regular intervals and to drain pipelines for repairs, maintenance and inspection. These devices are best suited to rural networks in which security of the units and disposal of the water flushed is less problematic. An additional drawback of installing these devices is the volume and value of the wasted water may be unacceptable. However, in networks with long pipe runs terminating in dead-ends, there may be few viable alternatives to flushing for controlling retention time.

5.2.5.4. Storage facility modifications

Most storage facilities have been designed focusing more on quantity, cost, service life, appearance and shape than on maintaining water quality. Water quality in storage facilities is affected by the mixing patterns that occur primarily during the filling cycle, the long-term residence time and the interaction between these two phenomena. Old water in stagnant zones can often have very high DBPs and low to no disinfectant residual. This water can be released into the system during periods of high demand. Increasing volume turnover reduces the average hydraulic residence time (HRT) in finished water storage facilities, thereby reducing DBP formation, loss of disinfectant and microbial growth. Kirmeyer and Friedman (2000) recommend complete turnover every three to five days but suggest that water systems establish their own turnover goal based on system-specific needs and goals. Improving mixing in finished water storage facilities can help eliminate stagnant zones. Mixing can be improved by increasing inlet momentum, changing the inlet configuration, increasing the fill time and by installing mixing devices within the storage facility (see the following discussion, **Sections 5.2.5.4.1** to **5.2.5.4.3** of this document).

It may be necessary to reduce the water volume in a storage tank or increase demand on the tank to achieve increased volume turnover. Decommissioning storage facilities may be an appropriate strategy to reduce water age if existing facilities are oversized and not needed for emergency conditions, fire protection or for maintaining system pressure. A professional engineer should review system needs, system design and operation to determine if the existing storage capacity and tank operation are appropriate.

5.2.5.4.1. Inlet / outlet configuration

Inlet and outlet configuration are critical in the development of proper mixing in a finished water storage facility. The inlet structure should be located and sized to disperse the jet into the storage facility as well as to maintain a jet sufficient for mixing. In particular, the location and orientation of the inlet pipe relative to the tank walls can have a significant impact on mixing characteristics. The physical modifications to the inlet pipe for improving mixing within the tanks include:

- Changing the orientation of the inlet pipe; and/or
- Decreasing the inlet diameter to increase the jetting action.

The outflow configuration does not significantly influence mixing, but operation of the inlet and outflow is important because flow entering the tank and leaving the tank at the same time can negatively impact mixing and should be avoided. Furthermore, when the inlet/outlet is a common pipe, the ability to reduce the inlet diameter to achieve a higher inflow velocity and

better jetting action will be constrained by the need to maintain an outflow capacity adequate to satisfy system operational and fire flow requirements. For this reason, it is recommended that PWSs eliminate common inlet/outlet pipes.

5.2.5.4.2. Installation of mixing devices

Mixing the storage facility contents to reduce stagnant zones can also be accomplished by installing mixing devices. Special precautions are recommended with mechanical mixing devices because of potential contamination to finished water by the mixer mechanism lubrication system. Multiple mixing devices may be needed so PWSs should consider the increased maintenance requirements inside the storage facility.

5.2.5.4.3. Increasing volume turnover

As mentioned earlier in this section, increasing the volume turnover reduces the average HRT in the storage tank. PWSs can accomplish turnover by making operational modifications to the storage tank such as increasing the water level fluctuation or drawdown between fill and draw cycles. The water level should be lowered in one continuous operation and not in small incremental drops throughout the day. This will help to mitigate microbial growth in the tank by decreasing the HRT or increasing the volume turnover by increasing the flow rate.

Operational modifications may be limited by the following considerations:

- Control of flow rates during tank filling may be needed to minimize the potential for low pressure in the distribution system; and
- Changes in operating protocol for booster stations and other tanks to achieve turnover while maintaining adequate pressure system-wide.

5.2.6. Maintenance of storage facility

Finished water storage tanks are an important component of a PWS's distribution system. Tanks are usually designed for three purposes: reduce pressure fluctuations in the distribution system, equalize water demands and provide water reserves for emergencies such as fires and power outages.

The two main categories of water storage tanks include ground storage tanks and elevated storage tanks (see previous discussion on elevated storage tanks in **Section 5.2.4.3** of this document). Ground storage tanks can be below grade, partially below grade or at ground level in a distribution system and are usually constructed of a variety of materials, including steel,

concrete and fiberglass reinforced plastic. Elevated storage tanks are typically constructed of steel.

Contamination from birds and insects can be a source of microbial contamination in the distribution system. Maintenance on a storage tank can significantly reduce the possibility of contamination or recontamination. Some actions PWSs can take include inspecting and cleaning, lining the interior of the tank, repairing vents and/or hatches and repairing the tank itself (see the following discussion, **Sections 5.2.6.1** to **5.2.6.4** of this document).

5.2.6.1. Inspection / cleaning of tanks

Tank inspections can provide useful information on the physical condition of the exterior and interior of the tank and on identifying potential sources of microbial contamination. Inspections can also identify the accumulation of sediment within storage tanks due to particle settling in the tank or the dissolving of cementitious materials of a concrete tank from soft, low alkalinity, low pH waters. There are several water quality issues associated with sediment buildup in a storage tank, including increased disinfection demand, microbial growth, DBP formation and increased turbidity.

5.2.6.2. Lining of storage tanks

Lining the interior of a water storage tank is another action that PWSs can take to reduce the potential for coliform contamination and recontamination of the distribution system. Corrosion and corrosion product buildup from excessive interior corrosion can also result in water quality issues such as increased disinfection demand, microbial growth and increased turbidity.

5.2.6.3. Vent / hatch repair

One of the most common sources of contamination in a water storage tank is the improper design and maintenance of vents and roof hatches. These accessories can provide entry points for debris as well as microbial contamination from birds and insects. Aging water storage tanks with damaged tank covers can also be a source of microbial contamination. To prevent contamination and recontamination of the water supply, damaged vents, hatch roofs and tank covers should be repaired or replaced immediately.

5.2.6.4. Tank repair

Aging water storage tanks can provide entry points for debris as well as microbial contamination from birds and insects and should be replaced or repaired immediately to prevent contamination and recontamination of the water supply.

5.2.7. Implementation or upgrade of a Cross-connection Control and Backflow Prevention Program

Implementing or upgrading a Cross-connection Control and Backflow Prevention (CCCBFP) Program, including the installation of backflow prevention assemblies and devices, can prevent the flow of non-potable substances into the distribution system. When implementing the CCCBFP Program, PWSs should adhere to applicable state and/or local criteria, codes and/or regulations. Some codes or regulations may include documenting installation procedures and the periodic testing of backflow prevention assemblies. CCCBFP can prevent the introduction of non-potable substances into the public water supply due to backsiphonage or backpressure.

Backflow prevention equipment installation and maintenance is generally the consumer's responsibility. However, depending on how a PWS implements the CCCBFP, the customer and the PWS can share costs for the equipment and equipment installation, inspection, testing and maintenance. The PWS, on the other hand, is primarily responsible for the administration of CCCBFP and the inspection, review and approval of all backflow prevention assemblies and devices.

5.2.8. Sampler training

Implementation of a sampler training program provides guidelines for procedures that samplers must follow to collect valid, uncontaminated samples for analysis of total coliforms in the distribution system. Training sessions for operators reinforce proper sampling and sample handling procedures to obtain uncontaminated samples.

5.2.9. Addition or upgrade of on-line monitoring and control

Currently, monitoring of total coliforms is performed through grab samples at the treatment plant and throughout the distribution system. These grab samples are then analyzed in a laboratory to determine whether total coliforms are present or not in the grab sample. To ensure sufficient treatment has been provided, grab sample results, disinfectant dosages and certain water quality parameters, such as disinfectant residual levels, can be correlated. Since automatic monitoring is not available for total coliforms, PWSs can instead automatically control and

monitor for disinfectant dosages and water quality parameters (see the following discussion, **Sections 5.2.9.1** to **5.2.9.2** of this document).

5.2.9.1. Water quality monitoring and control

A PWS's ability to monitor disinfectant residuals in the distribution system can allow it to determine if there is an area of possible contamination or an area that requires additional treatment. Low levels of disinfectant residuals in the system can be caused by an increase of organics in a system, which consume disinfectant residuals, or insufficient disinfectant dosages at the treatment facility. Maintenance of sufficient disinfectant residual levels in a distribution system is important in maintaining minimal levels of total coliforms in the system.

PWSs can monitor disinfectant residual using routine grab samples, with adjustment of dosages based on results. Controlling and monitoring disinfectant dosages and water quality parameters can also be performed through the use of a SCADA system at the treatment facility. Disinfectant dosing equipment can be monitored and analyzers can be placed in the treatment process to monitor water quality parameters. Monitoring water quality parameters via SCADA in a distribution system is possible; however, it can be costly. Determining the number and location of the analyzers is challenging and highly dependent upon the system size. Typically, analyzer equipment will draw samples from an above grade pipe or a sample tap to an analyzer that is placed in a building. Sample locations will require analyzer equipment, a building, electric power and, in the case of some systems, integration to the PWS's existing SCADA system. Method requirements for on-line amperometric chlorine monitors are more time intensive and difficult than grab sampling.

5.2.9.2. Pressure monitoring and control

In addition to water quality monitoring, PWSs can monitor pressure levels throughout the distribution system. Installing online pressure monitoring and control will help minimize future incidents of pressure loss that can allow entry of contaminants into the distribution system. It can also help a PWS determine if there are any physical problems in the system, e.g., a crack in a pipe, a leaking valve, etc., that cause changes to the water quality of the system. Pressure readings can also be used to help locate areas of deficiency in a distribution system. Similar to the water quality monitoring, determining the number of pressure monitors and their locations is dependent upon the system size. Pressure monitoring locations will likely require the same equipment as water quality sampling locations.

On-line distribution system monitoring through the SCADA system can alert operators if there are possible issues with the distribution system; however, monitoring the water quality or

pressure will not identify the source of the contamination nor will it necessarily identify the location of the contamination.

5.2.10. Addition of security measures

PWSs may need to install security measures in circumstances where the assessment or onsite inspection reveals vandalism or security breaches that could lead to water contamination. Measures that PWSs may take to correct security breaches include installing a fence or locking buildings to restrict access to the system. Other possible security measures include employing a full time, on-site security staff and using alarms and cameras to detect security breaches.

PWSs should prioritize their security measures and concentrate on the most vulnerable parts of their system, such as unstaffed facilities (e.g., finished water storage tanks). An important implementation issue is determining the extent to which the water system needs to be secured. This would depend on how widely spread the system/facility is, the number and complexity of the treatment trains, the extent of the watershed, the distance of the treatment plant from the influent wells, accessibility of the distribution system, etc.

Installing security measures can increase the public's confidence in the protection of their drinking water and indeed can provide substantial protection against vandalism that might result in contamination of the water. However, security measures are not always foolproof or absolute in combating vandalism or security breaches.

5.2.11. Development and implementation of an operations plan

PWSs may need to develop an operations plan or improve their existing one when the assessment identifies gaps in the way the system is operated that could have led to or contributed to the sanitary defect identified. For example, a broken valve might have been prevented if routine inspections were part of the operations plan. An operations plan can integrate all operations and maintenance functions to meet the goals of flow, pressure and water quality. The AWWA G200-04 standard describes the critical requirements for the effective operation and management of drinking water distribution systems. According to this standard, a water system should develop SOPs, comprehensive monitoring plans, routine inspections and emergency response plans.

5.2.11.1. Standard operating procedures

SOPs should be developed for each operation and maintenance function that affects the system's water quality (e.g., flushing programs, storage facility inspections). The water quality goals for both the distribution system and the particular function should be specified in the SOPs.

SOPs should be developed from information gathered from the various departments and crews involved in a given function. The SOPs should be written in terms that everybody will understand and they should include all activities needed to conduct the procedures and describe the labor, equipment and materials needed to complete the activity.

5.2.11.2. Sample siting plans

PWSs should establish a routine distribution system sampling plan that is representative of the entire distribution system (under the RTCR, PWSs are required to have a sample siting plan in place). At a minimum, the sample sites should include sites required for regulatory compliance monitoring (as those required by the RTCR and the GWR). Additional sites should be sampled as necessary to provide a complete picture of the water quality in the system. All samples should be collected in accordance with the latest edition of *Standard Methods for the Examination of Water and Wastewater* (as of the writing of this document, the latest version is that of APHA et al. 2005).

5.2.11.3. Routine inspections

Routine inspections of various distribution system components such as finished water storage facilities, water mains, pump stations, chemical storage facilities, valves and fire hydrants are critical to ensure high-quality water. PWSs should implement inspection and maintenance programs of these components as part of the SOPs.

5.2.11.4. Emergency response plan

A written emergency response plan for the distribution system allows operating personnel to respond efficiently, effectively and rapidly to an emergency situation. Water quality system safety and reliability are improved if a PWS has an emergency response plan.

5.2.11.5. Appropriately qualified operators

EPA established an operator certification program with minimum professional standards for the operation and maintenance of water systems. The EPA program issued guidelines that specify standards for certification and recertification of operators. States implement the minimum standards of the certification program guidelines. While the specific requirements vary from state to state, the goal of the program is to ensure that skilled professionals are overseeing the treatment and distribution of safe drinking water and compliance with the Safe Drinking Water Act (SDWA). More information on the operator certification program can be found at: *http://water.epa.gov/infrastructure/drinkingwater/pws/dwoperatorcert/index.cfm*.

Providing training sessions for operators reinforces proper operation and maintenance of water facilities and systems. These sessions can also help educate PWS staff on emerging treatment technologies, regulatory requirements and other advances in the drinking water industry.

5.3 What are some of the best practices PWSs can take?

Best practices are actions that PWSs should and/or might choose to take following a Level 1 or Level 2 trigger regardless of whether they have identified a sanitary defect or a likely cause of the total coliform or *E. coli* occurrence (e.g., a single *E. coli*-positive sample). They can range from temporary measures to long term measures.

In the survey conducted by AWWA, Association of Metropolitan Water Agencies (AMWA) and Association of State Drinking Water Agencies (ASDWA) (see footnote 9), most respondents indicated that follow-up actions are taken following a positive coliform result even when the underlying cause is unidentified. Systems take these actions to ensure public health protection and generally do not involve major construction or capital improvement. Examples of common actions that were reported are flushing, increasing disinfectant residual, collecting additional investigative samples, examining whether samples were collected from appropriate sample sites and re-training staff/sampler on proper sampling procedures. Based on the results of the survey, the list below includes these actions and a few other ones as examples of best practices that PWSs may take following an assessment trigger or a positive coliform result, regardless of whether the cause or the sanitary defect is identified. Some of them have already been discussed in **Section 5.2** of this document. These actions are not mutually exclusive and PWSs may choose to implement a combination of them, if appropriate. PWSs should also consider implications for long-term sustainability and public health protection when deciding which of these actions to implement.

The RTCR also identifies a list of "best technologies, treatment techniques, or other means" (also known as best available technologies (BATs)) to help PWSs comply with the rule (see §141.63(e) of the RTCR). They include appropriate well placement and construction, maintenance of a disinfectant residual throughout the distribution system, proper maintenance of the distribution system, filtration and disinfection of surface water, implementation of a cross-connection control program and implementation of a wellhead protection program. PWSs may choose to take advantage of these BATs when they trigger an assessment in order to avoid future triggers and/or violations, even if they are unable to find a likely cause/sanitary defect. Some of these BATs are also discussed in the list below.

- **Apply disinfection** – A discussion of disinfection practices is in **Section 5.2.1** of this document. Additional information on emergency disinfection practices can be found at *http://www.epa.gov/drink/emerprep/emergencydisinfection.cfm*
- **Change or update distribution system maintenance operations** – A well-maintained and operated distribution system is an important barrier in protecting water quality. Even if water from an extremely clean source is adequately treated, breakdowns in the distribution system can lead to waterborne illnesses. In particular, the contamination of treated water can result from main breaks, inadequate water pressure that allows intrusion or backflow of contaminants, deficiencies in storage tanks and inadequate separation of water supply lines and sewers.
  Proper maintenance of the distribution system includes appropriate pipe replacement and repair procedures, main flushing programs, proper operation and maintenance of storage tanks and reservoirs, cross-connection control and continual maintenance of positive water pressure in all parts of the distribution system. Even if a Level 1 or Level 2 assessment does not reveal an underlying cause for the positive coliform samples, a PWS may choose to change or update their distribution system maintenance operations as a follow-up action. Many of these actions are described in **Section 5.2.3** of this document.
- **Perform unscheduled or spot flushing** – A discussion of unscheduled or spot flushing is in **Section 5.2.2** of this document.
- **Implement sampler training** – A discussion of sampler training is in **Section 5.2.8** of this document.
- **Review sample siting plan** – The sample siting plan should ensure that the quality of the water is representative of the distribution system. PWSs might consider reviewing and revising the sample siting plan as a universal follow-up action, regardless of whether an underlying cause for the positive coliform samples can be identified.
- **Select appropriate sample sites** – Part of a successful sampling plan is the selection of clean, appropriate sample taps and sites from which to collect representative samples. In addition to reviewing the sample siting plan, PWSs may wish to consider the use of dedicated sample taps, which is discussed in **Section 5.2.3.6** of this document.
- **Collect additional follow-up samples** – Collecting follow-up total coliform samples after conducting a corrective action is a good practice to help determine the effectiveness of the corrective action. This action could also enhance public health protection by determining if there are still any sanitary defects that may not have been identified initially. Note, however, that additional follow-up total coliform sampling in itself, without any other corrective action, is not sufficient to address identified sanitary defects.
- **Institute boil water orders** – A number of systems have chosen to institute boil water orders even in cases where total coliforms are detected but no *E. coli* is present. In some states, boil water orders are a required follow-up action after a total coliform-positive sample has occurred. However, it should be noted that requirements vary from state to

state and PWSs should follow state requirements for implementing boil water orders, whether they are required in response to a total coliform-positive or not.

A boil water order requires that a PWS publicly advertise that water should be boiled prior to consumption. While a boil water order can be protective of public health, it also requires effort for consumers, has economic impacts to businesses and can undermine public confidence in the water supply. Therefore, a boil water order should not be implemented lightly and should be reserved for situations with significant potential to impact public health. A Level 2 trigger associated with an *E. coli*-positive may be more appropriate for a boil water order action than a Level 1 trigger associated with a total coliform-positive. Boil water orders may also be issued on a voluntary basis and may be helpful for educating sensitive populations.

6. Simultaneous Compliance with the RTCR and with the Requirements of Other Drinking Water Rules

6.1. Using sanitary surveys to meet the requirements of the RTCR

Some RTCR requirements can be met through a sanitary survey, such as conducting an assessment, review of monitoring frequency and the requirement for annual site visits for systems on reduced annual monitoring. This section discusses how states and PWSs can use the sanitary survey to meet these requirements. Note that the RTCR does not include new performance requirements for sanitary surveys, e.g., how and when to conduct sanitary surveys.

6.1.1. Sanitary surveys and assessments

Under the RTCR, an assessment of the water system is required if triggered under the rule (and as described in **Chapters 3** and **4** of this document) to identify possible sanitary defects within the distribution system. In addition to the RTCR requirements, the state must assure that a sanitary survey is conducted for each system every three or five years depending on the system type and other factors. The sanitary survey requirements for surface and ground water systems have been established for all system sizes and types under the Interim Enhanced Surface Water Treatment Rule (IESWTR) (USEPA 1998a) (40 CFR 142.16(b)(3)), and the GWR (USEPA 2006b) (40 CFR 142.16(o)(2)(i)). **There may be instances where the performance of an assessment or a sanitary survey can satisfy the requirements of the other**. It is therefore important for PWSs to understand how these two types of evaluations can be integrated.

This section discusses the basic differences and the overlaps between sanitary surveys and Level 1 and Level 2 assessments. It addresses what a sanitary survey is, how often it is performed, the objective of a sanitary survey, who performs them relative to Level 1 and Level 2 assessments, and the overlaps between assessments and sanitary surveys. It is not intended to represent guidance on the performance or requirements of conducting sanitary surveys. Other resources are available for that purpose. Sanitary survey resources, such as a prep course, learner's guide, and inspector's field guide can be found online at http://www.water.epa.gov/learn/training/dwatraining/sanitarysurvey/ .

6.1.1.1. What is a sanitary survey?

A sanitary survey is a comprehensive on-site evaluation of all water system components and operations and maintenance procedures.

A sanitary survey is defined in 40 CFR 141.2 as an: "onsite review of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation and maintenance for producing and distributing safe drinking water."

There are eight required elements that must be included in the review of a water system during a sanitary survey:

- Source,
- Treatment,
- Distribution system,
- Finished water storage,
- Pumps, pump facilities, and controls,
- Monitoring and reporting and data verification,
- System management and operation, and
- Operator compliance with state requirements.

The performance of comprehensive and periodic sanitary surveys is important in the identification and correction of significant deficiencies to ensure the long-term safety of drinking water supplies. Sanitary surveys are important tools for identifying potential vulnerabilities to fecal contamination. Each state is responsible for the definition of significant deficiencies and for providing examples of sanitary defects, so coordination with the state during both RTCR assessments and sanitary surveys is critical.

PWSs should coordinate with their states regarding how and when a combination of assessment and sanitary survey activities can be used to meet the requirements of both.

6.1.1.2. What are the differences and overlaps between a sanitary survey and a Level 1 or Level 2 assessment?

There are several differences between sanitary surveys and the assessments required under the RTCR, although the two sets of requirements can overlap. Some sanitary defects as determined during a Level 1 or Level 2 assessment could also be considered to be significant deficiencies under a sanitary survey, such as breaches in storage facilities or problems with a well seal. However, there are significant deficiencies that would not be considered to be sanitary defects, such as failure to meet operator

Sanitary defects that are identified during an assessment may or may not be considered a significant deficiency under other rules according to the guidelines set by each state.

qualification requirements. This section explains some of the differences and elements in common between a sanitary survey and an assessment.

6.1.1.2.1. What is the difference in scope?

A sanitary survey is generally broader in scope than either a Level 1 or Level 2 assessment. Although a sanitary survey includes some elements that are similar to those in an assessment (e.g., evaluation of the source water, the distribution system, storage facilities, etc.), a sanitary survey generally will cover additional items such as system management and operation that are beyond what an assessment requires under the RTCR. Because they are generally broader in scope, a state may in some situations allow a sanitary survey to be used to meet the requirements for a Level 1 or Level 2 assessment.

The Level 1 and Level 2 assessments are targeted to identify sanitary defects that provide pathways of entry for microbial contamination or those that are indicative of a failure or imminent failure in a barrier that is already in place. Nevertheless, there may be some assessments that will note best operational practices, such as regular flushing programs, that can be used to improve water quality regardless of whether the assessment identifies sanitary defect(s). Furthermore, for some system sizes and types, such as simple systems with limited sources and distribution systems, a sanitary survey and an assessment may be substantially the same.

6.1.1.2.2. What is the difference in frequency and timing?

Sanitary surveys are performed periodically and routinely on a schedule. The state must complete sanitary surveys for all surface water systems (including ground water under the direct influence of surface water) no less frequently than every three years for CWSs and no less frequently than every five years for NCWSs. CWSs must have sanitary surveys completed by the state or an agent approved by the state no less than every three years, with the possibility of having the frequency reduced to no less than every five years if the system has an outstanding performance or meets certain criteria. NCWSs (both non-transient and transient non-community) are required to have sanitary surveys performed by the state or an agent approved by the state no less often than every five years.

Level 1 and Level 2 assessments, on the other hand, are performed by a qualified PWS staff and a party approved by the state, respectively, in response to treatment techniques triggers, so they are not on a routine schedule. In some situations, based on the timing and schedule of the sanitary survey, the sanitary survey may be used to meet the assessment requirements of the RTCR if acceptable to the state. Assessments must be conducted within 30 days of a system triggering the assessment.

To the extent that the requirements to perform an assessment may be satisfied as part of the sanitary survey, PWSs and states may realize a cost savings by conducting a sanitary survey that also qualifies as an assessment instead of performing an additional separate assessment. Keep in mind, however, that the assessments conducted to meet RTCR requirements must be conducted within the required timeframe under the RTCR and may not be delayed to when the next sanitary survey is scheduled to be performed. Also, to meet the requirements of both, the person doing the assessment would also have to be qualified to conduct a sanitary survey, and vice versa, and the investigation would have to meet the minimum criteria specified by the state for both the assessment as well as the sanitary survey.

6.1.1.2.3. Who conducts them?

Sanitary surveys must be conducted by the state or an agent approved by the state. A Level 1 assessment is a self-assessment completed by qualified PWS staff and reviewed by the state. A Level 2 assessment is conducted by a party approved by the state, which could be a representative of the state, by a state-approved third party or by qualified PWS staff member(s) if the state determines they possess the required qualifications.

6.1.2. Sanitary surveys and monitoring

The RTCR allows PWSs to transition to the new rule at their 1989 TCR monitoring frequency, even if a system is on reduced monitoring under the 1989 TCR, provided they meet certain criteria. For ground water systems serving 1,000 or fewer people, their monitoring frequency must be evaluated by their state during each sanitary survey conducted after the compliance effective date of the RTCR. The purpose of these special monitoring evaluations is to make sure that these systems are on the appropriate monitoring frequency and to ensure that the distribution system is evaluated in sufficient detail. These **special monitoring evaluations** are not anticipated to significantly increase the burden of conducting sanitary surveys because the systems (serving 1,000 or fewer people) are relatively simple, and the evaluation is performed during the routinely scheduled sanitary survey. The addition of the special monitoring evaluation for the RTCR during the sanitary survey is also not changing the existing sanitary survey requirements under the IESWTR and the GWR.

The results of a sanitary survey can also directly impact a system's monitoring frequency under the RTCR. For a ground water system serving 1,000 or fewer people, the sanitary survey might uncover sanitary defects in the system that could affect its ability to qualify for reduced monitoring. To qualify for reduced monitoring, the system's most recent sanitary survey must show that the system is free of sanitary defects. See **Appendix A** of this document for a summary of the RTCR requirements.

6.1.3. Sanitary surveys and annual site visits

For years in which the state performs a sanitary survey of an NCWS, which is at least every five years, a sanitary survey performed during the same year can also be used to satisfy the annual site visit requirement for systems wanting to qualify for and stay on annual monitoring under the RTCR. A voluntary Level 2 assessment may also be used to satisfy the annual site visit requirement.

6.2. Changing treatment practices to comply with the corrective action requirements of the RTCR

The interrelated nature of regulations can be a challenge as adjustments to improve compliance for one rule may inadvertently affect a system's ability to comply with another rule. Given that temporary disinfection is a common corrective action taken by systems that have experienced positive coliform results, a number of related issues are important for PWSs to keep in mind with respect to other drinking water rules.

Non-transient non-community water systems (NTNCWSs) and CWSs that do not typically practice disinfection and are planning on adding temporary disinfection are subject to the Stage 1 and Stage 2 Disinfectants/Disinfection By-Products Rules (DBPRs) (40 CFR 141.130 and 141.600) (USEPA 1998b; USEPA 2006a) for the monitoring period in which the disinfectant is used. PWSs should check with their state to determine what the requirements are for compliance with the DBPRs. For temporary disinfection by chlorine or chloramines, PWSs will have to ensure that maximum residual disinfectant levels (MRDLs) for chlorine/chloramines and MCLs for total trihalomethanes (TTHM) and the group of five haloacetic acids (HAA5) are not exceeded. This may require additional sampling at both the point of entry of the chlorinated water and at other distribution system locations.

> PWSs should always check with their State before making any changes or additions to disinfection practices.

Alkalinity and pH adjustments and/or the addition of corrosion inhibitors are often used to meet Lead and Copper Rule (LCR) (40 CFR Part 141, Subpart I) requirements. For PWSs using measures such as these, they should also be aware that the pH of the water can alter the efficacy of disinfectants used to meet the requirements microbial rules such as the RTCR. For a given level of inactivation, the higher the pH, the higher the disinfection detention time and/or chlorine residual concentration required. See the *Revised Guidance Manual for Selecting Lead and Copper Control Strategies* (USEPA 2003) for more information on simultaneous compliance with the LCR and other drinking water regulations.

PWSs should also be aware that changes in disinfectant residual may alter the corrosivity of the water. Chlorine is a powerful oxidant and reacts with many metals that are present in the distribution system. Rapid changes between high concentrations and low (or no) concentrations of oxidants can destabilize metal scales that form along the pipe wall, possibly allowing for metal release into the water. Aggressive flushing can result in discolored water and potential for customer complaints.

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APPENDIX A. Summary of the RTCR Requirements

Appendix A gives a summary of the RTCR requirements (USEPA 2013 and USEPA 2014). Several tables are presented here to make it easier for the reader to refer to specific requirements of the RTCR. Note that the requirements presented here are the federal requirements of the RTCR. States may have additional requirements specific to their programs. Systems should check with their state to make sure they are complying with all the RTCR requirements specified by the state.

List of Tables

Acronyms Used in this Appendix

CWS	Community Water System
EC	*E. coli*
EC+	*E. coli*-positive
GW	Ground Water
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NA	Not Applicable
NCWS	Non-Community Water System
PN	Public Notification
PWS	Public Water System
RTCR	Revised Total Coliform Rule
SW	Surface Water
TC	Total Coliforms
TC+	Total Coliform-positive
TCR	Total Coliform Rule
TT	Treatment Technique

Table A-1: Summary of RTCR Requirements

Element	RTCR requirements
Rule construct §§ 141.52, 141.63, 141.853, 141.859	• The RTCR sets an *E. coli* (EC) maximum contaminant level goal (MCLG) of zero and an EC maximum contaminant level (MCL) and a coliform treatment technique (TT) based on total coliform (TC) and/or EC monitoring results. • Compliance is based on the presence or absence of TC and EC and is determined each calendar month the PWS serves water to the public (or each calendar month that sampling occurs for systems on less-than-monthly monitoring). See sections on "Assessment" and "Violations and Public Notification (PN)" in this table for conditions when the coliform TT and EC MCL are violated. • Assessment and corrective action (if necessary) are required if PWS has a coliform treatment technique trigger. See sections on "Assessment" and "Corrective Action" in this table.
Transition from the 1989 TCR to the RTCR §§ 141.854 to 141.857	• PWSs continue on their existing 1989 TCR monitoring schedule when the RTCR is effective. • Ground water (GW) systems serving 1,000 or fewer persons remain on their 1989 TCR schedule unless or until the conditions occur as described below or unless otherwise directed by the state. o Non-community water systems (NCWSs) on quarterly/annual monitoring remain on that schedule unless/until they have an event that triggers increased monitoring. See **Table A-5** and **Table A-6** in this appendix. o Community water systems (CWSs) on reduced monitoring remain on that schedule unless/until they have an event that triggers them to return to monthly monitoring. See **Table A-7** in this appendix. o Monitoring schedules will be evaluated during the "special monitoring evaluation" conducted by the state as part of the periodic sanitary survey.

Element	RTCR requirements
Routine Monitoring §§ 141.853 to 141.858	• Total coliform samples must be collected at sites that are representative of water quality throughout the distribution system according to a written sample siting plan subject to state review and revision. See **Table A-2** in this appendix for additional information regarding the sample siting plan and which elements of it require state approval before implementation. • Samples must be collected at regular time intervals throughout the month except some small systems may collect them on the same day. See **Table A-3** in this appendix for the minimum number of samples PWSs must collect each month. • The number of monthly samples is based on population served. Reduced monitoring is available for GW systems serving 1,000 or fewer people that meet certain criteria. • Systems on less than monthly monitoring may be triggered to increase their monitoring if certain conditions occur. *See **Table A-5**, **Table A-6** and **Table A-7** in this appendix for summaries of the monitoring requirements (i.e., reduced monitoring and increased monitoring criteria) for GW systems serving 1,000 or fewer people.* • Each total coliform-positive routine sample must be tested for the presence of EC and three repeat samples must be taken. • Monitoring provisions are included for seasonal systems,[11] which require them to monitor monthly, have a sample siting plan and to demonstrate state-approved start-up procedure. Reduced monitoring may be available for some small seasonal GW systems that meet certain criteria. See **Table A-6** in this appendix.
Repeat Monitoring §§ 141.853, 141.858	• All PWSs must take 3 repeat samples after a TC+ sample at locations specified in the sample siting plan. • For GW PWSs serving 1,000 people or fewer, a single sample can meet both the triggered source water requirements of the GWR and the repeat sample requirements of the RTCR, but only if the state approves the use of the single sample to meet both rule requirements and the use of EC as the fecal indicator. Otherwise, the system must take an additional source sample to comply with the GWR.
Additional Routine Monitoring §§ 141.854, 141.855	• A PWS taking routine samples less than monthly is required to take a minimum of 3 routine samples the following month it serves water to the public after a TC+ sample, unless the state waives the requirement.

[11] A seasonal system is defined as a non-community water system that is not operated as a public water system on a year-round basis and starts up and shuts down at the beginning and end of each operating period.

Element	RTCR requirements
Assessment § 141.859	• The PWS must conduct a Level 1 assessment if it exceeds any of the following triggers: o For systems taking ≥ 40 samples per month, the PWS exceeds 5.0% TC+ samples for the month; or o For systems taking < 40 samples per month, the PWS has ≥ 2 TC+ samples for the month; or o The PWS fails to take every required repeat sample after any single routine TC+ sample. • The PWS must ensure that a Level 2 assessment is conducted either by the state or a state-approved party (which could include a qualified PWS employee(s)) if it exceeds any of the following triggers: o The PWS has an EC MCL violation. o The PWS has a second Level 1 trigger within a rolling 12-month period, or in 2 consecutive years for systems on annual monitoring. • The system must complete the assessment as soon as practical after failure to take a repeat sample or after notification of results (i.e., after it determines that an assessment trigger has been exceeded). • Assessment results and description of corrective action(s) taken must be submitted to the state within 30 days after determination of exceeding the trigger. The state must determine if the assessment is sufficient, whether or not a sanitary defect is found.
Corrective Action § 141.859	• System must correct all sanitary defects found in the assessment. • For corrections not completed by the time the assessment form is submitted, the system must be in compliance with a state-determined schedule and must notify the state when completed.
Violations and Public Notification (PN) §§ 141.153, 141.202, 141.203, 141.204, 141.860	• EC MCL violation – when any of the following occurs; requires Tier 1 PN. o EC+ repeat sample following a TC+ routine sample o TC+ repeat sample following an EC+ routine sample o Failure to take all required repeat samples following an EC+ routine sample o Failure to test for EC when any repeat sample is TC+ • Coliform TT violation – when any of the following occurs; requires Tier 2 PN. o Failure to conduct required assessment or corrective action within the specified timeframe o Failure of a seasonal system to complete a state-approved start-up procedure

Element	RTCR requirements
	• Monitoring violation – when any of the following occurs; requires Tier 3 PN. o Failure to take every required routine or additional routine sample in a compliance period o Failure to analyze for EC following a TC+ routine sample • Reporting violation – when any of the following occurs; requires Tier 3 PN. o Failure to submit a monitoring report or completed assessment form after a system properly conducts monitoring or assessment o Failure to notify the state following an EC+ sample as required by § 141.858(b)(1) o Failure to submit certification of completion of state-approved start-up procedure by a seasonal system • Consumer Confidence Reports – language specific to the RTCR to be included in report is provided in §§ 141.153(c)(4), (d)(4) and (h)(7).
Reporting and Recordkeeping § 141.861	• A system must report the following to the state (in addition to those required by § 141.31): o Notification of an EC+ sample or EC MCL violation by the end of the day or before the end of the next business day if the state office is closed. In the case of an MCL violation, the system must also issue a Tier 1 PN. o A coliform TT violation by the end of the next business day after learning of the violation. A coliform TT violation also requires a Tier 2 PN. o A monitoring violation within 10 days after learning of the violation; also requires a Tier 3 PN. o Submission of the assessment form within 30 days of being triggered into doing an assessment. A system must notify the state when each scheduled corrective action is completed for corrections not completed when the form was submitted. o For a seasonal system, certification that it has completed a state-approved start-up procedure. • A system must keep records of the following (in addition to those required by § 141.33): o Any assessment form and documentation of corrective actions completed for no less than five years. o Any repeat sample taken that meets the state criteria for extending the 24-hour period for collecting repeat samples.

Table A-2: Sample Siting Plan Requirement for State Review and Approval

Requirement	Is the system required to submit the plan / element of the plan to the State?	Is the plan / element of the plan subject to State review/revision?	Does the plan / element of the plan require State approval before implementation?
Sample siting plan (other than below) § 141.853(a)(1)	No. The state can review the sample siting plan during the sanitary survey or other contact between the state and the system.	Yes	No
Alternative repeat sampling locations (other than +/- 5 service connections) § 141.853(a)(5)(i)	Yes	Yes	No
Less than monthly monitoring for seasonal systems § 141.854(i)(2)(i)	Yes	Yes	Yes
Use of dual purpose samples § 141.853(a)(5)(ii)	Yes	Yes	Yes

Table A-3: PWS Routine Monitoring Frequency

Population served	Minimum number of TC samples per month	Population served	Minimum number of TC samples per month
1,000 or fewer	See Table A-4	59,001 to 70,000	70
1,001 to 2,500	2	70,001 to 83,000	80
2,501 to 3,300	3	83,001 to 96,000	90
3,301 to 4,100	4	96,001 to 130,000	100
4,101 to 4,900	5	130,001 to 220,000	120
4,901 to 5,800	6	220,001 to 320,000	150
5,801 to 6,700	7	320,001 to 450,000	180
6,701 to 7,600	8	450,001 to 600,000	210
7,601 to 8,500	9	600,001 to 780,000	240
8,501 to 12,900	10	780,001 to 970,000	270
12,901 to 17,200	15	970,001 to 1,230,000	300
17,201 to 21,500	20	1,230,001 to 1,520,000	330
21,501 to 25,000	25	1,520,001 to 1,850,000	360
25,001 to 33,000	30	1,850,001 to 2,270,000	390
33,001 to 41,000	40	2,270,001 to 3,020,000	420
41,001 to 50,000	50	3,020,001 to 3,960,000	450
50,001 to 59,000	60	3,960,001 or more	480

§ 141.857 (b)

Table A-4: Routine Monitoring Frequency for PWSs Serving ≤ 1,000 Persons

System Type		Increased	Baseline	Reduced	Transition to the RTCR
CWS	**GW**	NOT APPLICABLE	1 / month	1 / quarter	Same frequency under the 1989 TCR
	SW	NOT APPLICABLE	1 / month	NA	NA (1 / month)
NCWS	**SW**	NOT APPLICABLE	1 / month	NA	NA (1 / month)
	GW non-seasonal	1 / month	1 / quarter	1 / year	Same frequency under the 1989 TCR[a]
	GW seasonal	NOT APPLICABLE	1 / month	1 / quarter or 1 / year	Same frequency under the 1989 TCR[b]

§§ 141.854 and 141.855

[a] For annual monitoring, system must have site visit by the state or voluntary Level 2 assessment in 1st and subsequent years.

[b] For quarterly monitoring, system must identify vulnerable period for monitoring. For annual monitoring, system must identify vulnerable period for monitoring and have site visit by the state or voluntary Level 2 assessment in 1st and subsequent years.

Table A-5: Routine Monitoring Requirements for GW NCWSs Serving ≤ 1,000 Persons (Non-Seasonal)

Baseline monitoring frequency: Quarterly (§ 141.854(b))

Reduced monitoring (annual) criteria § 141.854(e)	**Increased monitoring criteria** § 141.854(f)	**Return to baseline (quarterly) monitoring criteria** § 141.854(g)	**Return to annual monitoring criteria** § 141.854(h)
The state may reduce the monitoring frequency for a well-operated system to no less than annual monitoring if the system demonstrates that it meets the following criteria: 1. The system has a clean compliance history for a minimum of 12 months. 2. The most recent sanitary survey shows that the system is free of sanitary defects or has corrected all identified sanitary defects, has a protected water source and meets approved construction standards. 3. The state has conducted an annual site visit within the last 12 months and the system has corrected all identified sanitary defects. The system may substitute a Level 2 assessment that meets the criteria in §141.859(b) for the state annual site visit.	A system on reduced monitoring must begin either monthly or quarterly monitoring (in the month or quarter following the event, respectively) if any of the following conditions occur: *To Monthly* *(from quarterly or annual)* • The system triggers a Level 2 assessment or two Level 1 assessments under the provisions of §141.859 in a rolling 12-month period. • The system has an *E. coli* MCL violation. • The system has a coliform treatment technique violation. • For systems on quarterly, the system has two RTCR monitoring violations or one RTCR monitoring violation and one Level 1 assessment in a rolling 12-month period.	The state may reduce the monitoring frequency for a system back to quarterly monitoring, after it has been triggered into monthly monitoring, if it meets the following criteria: 1. Within the last 12 months, the system must have a completed sanitary survey or a site visit by the state or a voluntary Level 2 assessment by a party approved by the state, be free of sanitary defects and have a protected water source. 2. The system must have a clean compliance history for a minimum of 12 months.	The state may reduce the monitoring frequency for a system back to annual monitoring, after it has been triggered into a more frequent monitoring, if it meets the following criteria: 1. Must meet "return to baseline monitoring" criteria. 2. An annual site visit by the state and correction of all identified sanitary defects. The system may substitute a voluntary Level 2 assessment by a party approved by the state for the state annual site visit in any given year. 3. The system must have in place or adopt one or more additional enhancements to the water system barriers to contamination. • Cross connection control, as approved by the state.

Reduced monitoring (annual) criteria § 141.854(e)	**Increased monitoring criteria** § 141.854(f)	**Return to baseline (quarterly) monitoring criteria** § 141.854(g)	**Return to annual monitoring criteria** § 141.854(h)
	To Quarterly *(from annual)* • The system has one RTCR monitoring violation.		• An operator certified by an appropriate state certification program or regular visits by a circuit rider certified by an appropriate state certification program. • Continuous disinfection entering the distribution system and a residual in the distribution system in accordance with criteria specified by the state. • Demonstration of maintenance of at least a 4-log removal or inactivation of viruses as provided for under § 141.403(b)(3). • Other equivalent enhancements to water system barriers as approved by the state.

Table A-6: Routine Monitoring Requirements for GW NCWSs Serving ≤ 1,000 Persons (Seasonal)

Baseline monitoring frequency: Monthly (§ 141.853(i)(2))

Reduced monitoring (quarterly) criteria §§ 141.854(g) & 141.854(i)(2)(ii)	**Reduced monitoring (annual) criteria** §§ 141.854(h) & 141.854(i)(2)(iii)	**Return to monthly or quarterly monitoring criteria** § 141.854(f)
The state may reduce the monitoring frequency to no less than quarterly monitoring if the system demonstrates that it meets the following criteria: 1. System must have an approved sample siting plan that designates the time period for monitoring based on site-specific considerations (e.g., during periods of highest demand or highest vulnerability to contamination). Seasonal systems must collect compliance samples during this time period. 2. Within the last 12 months, the system must have a completed sanitary survey or a site visit by the state or a voluntary Level 2 assessment by a party approved by the state, be free of sanitary defects and have a protected water source.	The state may reduce the monitoring frequency for a well-operated system to no less than annual monitoring if the system demonstrates that it meets the following criteria: 1. System must meet "reduced quarterly monitoring" criteria. 2. An annual site visit by the state and correction of all identified sanitary defects. The system may substitute a voluntary Level 2 assessment by a party approved by the state for the state annual site visit in any given year. 3. The system must have in place or adopt one or more additional enhancements to the water system barriers to contamination. • Cross connection control, as approved by the state. • An operator certified by an appropriate state certification program or regular visits by a circuit rider certified by an appropriate state certification program. • Continuous disinfection entering the distribution system and a residual in the distribution system in accordance with criteria specified by the state.	A system on a reduced monitoring frequency must begin monthly or quarterly monitoring (in the month or quarter following the event, respectively) if any of the following conditions occurs: *Monthly* *(from quarterly or annual)* • The system triggers a Level 2 assessment or two Level 1 assessments under the provisions of §141.859 in a rolling 12-month period. • The system has an EC MCL violation. • The system has a coliform treatment technique violation. • The system has two RTCR monitoring violations. • The system has one RTCR monitoring violation and one Level 1 assessment in a rolling 12-month period for a system on quarterly monitoring.

Reduced monitoring (quarterly) criteria §§ 141.854(g) & 141.854(i)(2)(ii)	**Reduced monitoring (annual) criteria** §§ 141.854(h) & 141.854(i)(2)(iii)	**Return to monthly or quarterly monitoring criteria** § 141.854(f)
3. The system must have a clean compliance history for a minimum of 12 months.	• Demonstration of maintenance of at least a 4-log removal or inactivation of viruses as provided for under § 141.403(b)(3). • Other equivalent enhancements to water system barriers as approved by the state.	*Quarterly* *(from annual)* • The system has one RTCR monitoring violation.

Table A-7: Routine Monitoring Requirements for GW CWSs Serving ≤ 1,000 Persons

Baseline monitoring frequency: Monthly (§ 141.855(b))

Reduced monitoring (quarterly) criteria § 141.855(d)	**Return to monthly monitoring criteria** § 141.855(e)
The state may reduce the monitoring frequency to no less than quarterly monitoring if a system demonstrates that it meets the following criteria: 1. The system is in compliance with the state-certified operator provisions. 2. The system has a clean compliance history for a minimum of 12 months. 3. The most recent sanitary survey shows the system is free of sanitary defects (or has an approved plan and schedule to correct them and is in compliance with the plan and the schedule), has a protected water source and meets approved construction standards. 4. The system meets at least one of the following criteria: • An annual site visit by the state that is equivalent to a Level 2 assessment or an annual Level 2 assessment by a party approved by the state and correction of all identified sanitary defects (or an approved plan and schedule to correct them and is in compliance with the plan and schedule). • Cross connection control, as approved by the state. • Continuous disinfection entering the distribution system and a residual in the distribution system in accordance with criteria specified by the state. • Demonstration of maintenance of at least a 4-log removal or inactivation of viruses as provided for under § 141.403(b)(3) of the GWR. • Other equivalent enhancements to water system barriers as approved by the state.	A system on a quarterly monitoring frequency must return to a monthly monitoring frequency in the month following the occurrence of any of the following events: • The system loses its certified operator. • The system triggers a Level 2 assessment or two Level 1 assessments in a rolling 12-month period. • The system has an *E. coli* MCL violation. • The system has a coliform treatment technique violation. • The system has two RTCR monitoring violations in a rolling 12-month period.

APPENDIX B. Example Assessment Forms

The following are examples of Level 1 and Level 2 assessment forms developed by the Total Coliform Rule Distribution System Advisory Committee Technical Work Group. States may develop their own forms that address the five minimum elements of an assessment.

CONCEPT EXAMPLE

Level 1 Assessment Form

(Developed by the Technical Workgroup Supporting the Total Coliform Rule Distribution System Advisory Committee)

System Name:	Source Water:	PWSID #
System Type:	Population Served:	PWS Address:
Operator in Responsible Charge (ORC):	Phone:	
City, State:		
County:		
Person that collected TC samples if different than ORC:	Phone:	
Address, City, State, Zip:		
Date Assessment Completed:		

Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1. Evaluate sample site. -condition or location of tap -regular use of connection				
2. Sample protocol followed and reviewed. -flush tap -remove aerator -no swivel -fresh sample bottles -sample storage acceptable				
3. Have any of the following occurred at relevant facilities prior to the collection of TC samples? -any interruptions in the treatment process -any reported loss of pressure events (5 psi) -operation and maintenance activities that could have introduced total coliform -reported vandalism and/or unauthorized access to facilities -visible indicators of unsanitary conditions reported -Has there been a fire fighting event, flushing operation, sheared hydrant, etc.				
4. Have there been any recent operational changes to the system? -sources introduced -treatment or operational changes -potential sources of contamination				
5. Distribution System -system pressure -cross connection -pump station -air relief valves -fire hydrants or blow off -breaks -repairs				
6. Storage Tank -screens -security -access opening -condition of tank -vent -drain overflow -pressure tank -O&M				

EXAMPLE

CONCEPT EXAMPLE
Level 1 Assessment Form
(Developed by the Technical Workgroup Supporting the Total Coliform Rule Distribution System Advisory Committee)

Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
7. Treatment Process -interruptions -POE/POU -softeners -O&M				
8. Source – Well -sanitary seal -vent screened -air gap -cross connection -security -pump to waste line				
9. Source – Spring -condition of spring development -condition of spring box -security				
10. Source - Surface Water Supply -heavy rainfall -rapid snowmelt				

EXAMPLE

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: Date:
Signature:

Reserved for State

1.	Assessment has been successfully completed.	
2.	Likely reason for total coliform-positives occurrence is established.	
3.	System has corrected the problem.	
4.	Was a reset requested and / or granted? – Rationale	
5.	Name of State reviewer:	

CONCEPT EXAMPLE
Level 2 Assessment Form
(Developed by EPA and the Technical Workgroup Supporting the Total Coliform Rule Distribution System Advisory Committee)

System Name:	Source Water:	PWSID #
System Type:	Population Served:	PWS Address:
Operator in Responsible Charge (ORC):	Phone:	
City, State:		
County:		
Person that collected TC samples if different than ORC:	Phone:	
Address, City, State, Zip:		
Date Assessment Completed:		

	Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1.	**Evaluate sample site**				
a.	What is the condition of the tap? **(Provide comments)**				
b.	What is the location of the tap? **(Provide comments)**				
c.	What is the regular use of the connection? **(Provide comments)**				
d.	Have there been any plumbing changes or construction? If yes, when and what was the repair or change?				
e.	Have there been any plumbing breaks or failure? If yes, when?				
f.	List any identified cross connections after the service connection or in premise plumbing. **(Provide comments)**				
g.	Were all of the backflow prevention devices present, operational and maintained?				
h.	Were there any low pressure events or changes in water pressure after the service connection or in the premise plumbing? If yes, when?				
i.	Are there any treatment devices after the service connection or in premise? **(Circle response, if applicable)**	Point of Entry (POE)	Point of Use (POU)		
j.	Other comments on sample site?				

EXAMPLE

CONCEPT EXAMPLE
Level 2 Assessment Form
(Developed by EPA and the Technical Workgroup Supporting the Total Coliform Rule Distribution System Advisory Committee)

	Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
2.	**Sample protocol followed and reviewed**				
2.	Sample protocol followed and reviewed				
a.	Flush tap, remove aerator, no swivel, fresh sample bottles, sample storage acceptable				
3.	**Have any of the following occurred at relevant facilities prior to the collection of TC samples?**				
a.	Were there any operation and maintenance activities that could have introduced total coliforms?				
b.	Have there been any interruptions in the treatment process?				
c.	Has the system lost pressure to less than 5 psi?				
d.	Have there been any vandalism and/or unauthorized access to facilities?				
e.	Are there any visible indicators of unsanitary conditions observed?				
f.	Have there been any analytical results or any additional samples collected, including source samples which were positive (not for compliance)?				
g.	Have there been any community illness suspected of being waterborne (e.g., Does the community public health official indicate that an outbreak has occurred.)				
h.	Did the water system receive any TCR monitoring violations in the past 12 months? If yes, when.				
i.	What was the most recent date on which satisfactory total coliform samples were taken?	Date: _____			
j.	Have there been a fire fighting event, flushing operation, sheared hydrant, etc.				
k.	Other comments on records and maintenance?				
4.	**Have there been any recent treatment or operational changes?**				
a.	Have any inactive sources recently been introduced into the system (e.g., auxiliary systems)?				
b.	Have there been any new sources introduced into the system?				
c.	Is there evidence of any potential sources of contamination (main breaks, low pressure, high				

EXAMPLE

	Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
	turbidity, loss of disinfection, etc.)?				
5.	**Distribution System**				
a.	System pressure: Is there evidence that the system experienced low or negative pressure? If yes, when?				
b.	List any identified cross connections.				
c.	Pump station: Are there any sanitary defects in the pump station? Are pump(s) operable?				
d.	Last pump maintenance/service date. **(Respond if applicable)**	Date: _____		Maintenance Performed?	
e.	Air relief valves: Is the valve vault subject to flooding or does the vent terminate below grade?				
f.	Fire hydrant/blow off: Are any located in an area with a high water table or pits?				
g.	Is the distribution system secured to prevent unauthorized access?				
h.	Are the backflow prevention devices at high risk sites present, operational and maintained?				
i.	Have there been any water main repairs or additions? If yes when, and what was the repair or addition?				
j.	Have there been any water main breaks? If yes, when?				
k.	Was there any scheduled flushing of the distribution system? If yes, when?				
l.	Is there any evidence of intentional contamination in the distribution system?				
m.	Other comments on the distribution information.				
6.	**Storage Facilities**				
a.	Are the overflow and vents properly screened?				
b.	Is the facility secured to prevent unauthorized access?				
c.	Does the Access opening have the proper gasket and seal tightly?				
d.	Could the physical condition of tank be a source of contamination?				

EXAMPLE

	Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
e.	Is the Vent turned down and maintain an approved air gap at the termination point?				
f.	Does the Drain/overflow line terminate a minimum of 12" air gap?				
g.	If present, Is the Pressure tank maintaining an appropriate minimum pressure?				
h.	Is proper O&M being performed?				
i.	Was there any observed physical deterioration of the tank?				
j.	Were there any observed leaks?				
k.	Is there any evidence of intentional contamination at the storage tank?				
l.	Have there been any facility maintenance? (i.e. painting/coating) If yes, when?				
m.	Is facility maintenance occurring per appropriate schedule?				
n.	Does the tank "float" on the distribution system or are there separate inlet and outlet lines?				
o.	What is the measured chlorine residual (total/free) of the water exiting the storage tank today?	Residual _____			
p.	Are there any unsealed openings in the storage facility such as access doors, vents or joints?				
q.	Other comments on the storage system				
7.	**Treatment Process. (If applicable)**				
a.	Treatment devices operational and maintained?				
b.	Is there any recent installation or repair of treatment equipment?				
c.	Were there any recent changes in the treatment process? If yes, when, what was the change?				
d.	Were there any interruptions of treatment (lapses in chemical feed, turbidity excursions, disinfection)? If yes which part, when and for how long?				
e.	What is the free chlorine residual measured immediately downstream from the point of application?	**Residual: _____**			

EXAMPLE

CONCEPT EXAMPLE
Level 2 Assessment Form
(Developed by EPA and the Technical Workgroup Supporting the Total Coliform Rule Distribution System Advisory Committee)

	Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
f.	Did a review of the filter turbidity profiles reveal any anomalies?				
g.	Were there any failures to meet the CxT calculations?				
h.	Were the flow rates above the rated capacity?				
i.	Were there any anomalies on the settled water turbidities?				
j.	Other comments on the treatment system.				
8.	**Source – Well**				
a.	Is the sanitary seal intact?				
b.	Is the vent screened?				
c.	Does the vent and pump to waste terminate in an approved air gap?				
d.	Are there any unprotected cross connections at the wellhead?				
e.	How is the well used? **(Circle if applicable)**	Primary Backup Emergency Not a PWS Not Drinking Water			
f.	How far does the casing extend above grade?	Height _____		Comments:	
g.	Is the well cap vented?				
h.	Is there evidence of standing water near the wellhead?				
i.	Is the wellhead secured to prevent unauthorized access?				
j.	Have there been any sewer spills, source water spills or other disturbances?				
k.	Other comments on the well system. (Are there aspects of well construction and operation that would bear on observed positives?)				
9.	**Source – Spring**				
a.	What is the condition of the spring development?				
b.	What is the condition of the spring box?				
c.	Is the spring secured to prevent unauthorized access?				

EXAMPLE

CONCEPT EXAMPLE
Level 2 Assessment Form
(Developed by EPA and the Technical Workgroup Supporting the Total Coliform Rule Distribution System Advisory Committee)

Questions	Reviewed? (check if completed or type N/A)	Issue(s) Found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
d. Other comments on the spring system.				
10. Source - Surface Water Supply				
a. Have there been any sewer spills, source water spills or other disturbances?				
b. Have there been any Algal blooms?				
c. Has source water turnover occurred?				
d. Other source water comments				
11. Environmental Events				
a. Has there been heavy rainfall?				
b. Has there been any rapid snow melt or flooding?				
c. Have there been changes in available source water (e.g., significant drop in water table, well levels, reservoir capacity, etc.)				
d. Have there been any Interruptions to electrical power?				
e. Have there been any extremes in heat or cold?				

EXAMPLE

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: Date:
Signature:

Reserved for State

1. Assessment has been successfully completed. ☐ Name of State Reviewer: _____

APPENDIX C. Examples of Completed Assessments

This appendix provides examples of completed Level 1 and Level 2 assessment forms (using the forms presented in **Appendix B**). Some states are already requiring some form of assessment and the completion of an assessment form whenever a PWS has a total coliform-positive sample. Those states provided EPA with some of the completed assessments performed by their respective PWSs. EPA developed the examples in this appendix based on the assessment forms provided by the states. Personal information about the PWS or any person mentioned in the example forms is fictitious in nature. They are provided to show the types of information that are expected to be included in the form.

Table C-1: List of Examples

Example No.	System Type	Source Water	Population Served (Number of routine TC samples per month)	Assessment Type	Identified sanitary defect
1	NCWS (non-transient)	Ground Water	120 (1)	Level 1	None
2	CWS	Ground Water	24,200 (25)	Level 1	Air release valve submerged in flooded vault
3	CWS	Spring	5,500 (6)	Level 1	Small fractures in the water main
4	CWS	Ground water under the direct influence of surface water	985,000 (300)	Level 1	Pressure loss that resulted in stagnant water in one of the tanks to be pulled into the distribution system
5	CWS	Ground water	2,250 (3)	Level 2	Unsanitary conditions around a well
6	NCWS (transient)	Ground water	200 (1 / quarter)	Level 2	Inadequate chlorination after a repair / replacement activity

Assessment Form Instructions

1. Fill in system information under the first section of the form. The following information must be provided at a minimum:
   - System Name
   - Source Water (GW, SW, GWUDI, Purchased)
   - System Type (CWS, NTNCWS, TNCWS)
   - Population Served
   - Operator in Responsible Charge (ORC)
   - Phone
   - City, State
   - PWSID #
   - PWS Address

2. Respond to all Questions 1-10:
   - Type "✓" in the box for the items that were reviewed and checked or "N/A" if the item is not applicable to the system.
   - Print "Yes" or "No" in the "Issue(s) found?" column.
   - Describe any issues found and corrective action taken.
   - Be sure to include dates of any corrective actions taken.

3. Sign and date form on last page. Form must be completed based on data and documents available to the PWS operator in charge, maintained on file and sent to the primacy agency within 30 days of triggering the assessment.

Example No. 1 – Level 1 Assessment

UTILITY PROFILE
Buttermilk Falls Country Club is a non-transient, non-community water system that gets its water from a ground water source. It collects 1 routine sample per month. The system does not have any records of past violations.

DESCRIPTION OF THE PROBLEM
In November 2009, the routine monthly sample and one of its associated repeat samples came back positive for total coliforms. This triggered a Level 1 assessment.

ASSESSMENT AND CORRECTIVE ACTION
All applicable items listed in the Level 1 assessment form were all checked. Nothing unusual was found and all of the subsequent repeat samples came back negative.

CONCEPT EXAMPLE NO. 1
Level 1 Assessment Form

System Name: **Buttermilk Falls Country Club**	Source Water: **Ground Water**	PWSID # **1234567**
System Type: **NTNCWS**	Population Served: **120**	PWS Address: **123 Anyway St., Buttermilk Falls, MS 10000**
Operator in Responsible Charge (ORC): **J. Griffin**	Phone: **012-345-6789**	
City, State: **Buttermilk Falls, MS**		
County: **Hoover**		
Person that collected TC samples if different than ORC: **C. Gary, HHH Labs**	Phone: **123-456-7890**	
Address, City, State, Zip: **222 Second St., Buttermilk Falls, MS 12121**		
Date Assessment Completed: **11/12/2009**		

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1. Evaluate sample site. -condition or location of tap -regular use of connection	✓	**No**		
2. Sample protocol followed and reviewed. -flush tap -remove aerator -no swivel -fresh sample bottles -sample storage acceptable	✓	**No**		
3. Have any of the following occurred at relevant facilities prior to the collection of TC samples? -any interruptions in the treatment process -any reported loss of pressure events (5 psi) -operation and maintenance activities that could have introduced total coliform -reported vandalism and/or unauthorized access to facilities -visible indicators of unsanitary conditions reported -Has there been a fire fighting event, flushing operation, sheared hydrant, etc.	✓	**No**		
4. Have there been any recent operational changes to the system? -sources introduced -treatment or operational changes -potential sources of contamination	✓	**No**		
5. Distribution System -system pressure -cross connection -pump station -air relief valves -fire hydrants or blow off -breaks -repairs	✓	**No**		

CONCEPT EXAMPLE NO. 1
Level 1 Assessment Form

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
6. Storage Tank -screens -security -access opening -condition of tank -vent -drain overflow -pressure tank -O&M	**N/A**			
7. Treatment Process -interruptions -POE/POU -softeners -O&M	**N/A**			
8. Source - Well -sanitary seal -vent screened -air gap -cross connection -security -pump to waste line	✓	**No**		
9. Source - Spring -condition of spring development -condition of spring box -security	**N/A**			
10. Source - Surface Water Supply -heavy rainfall -rapid snowmelt	**N/A**			

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:
At this time, the obvious cause of the total coliform-positive results has not been identified.

Reserved for State

1. Assessment has been successfully completed.	
2. Likely reason for total coliform-positive occurrence is established.	
3. System has corrected the problem.	
4. Was a reset requested and / or granted? – Rationale	
5. Name of State reviewer:	

Example No. 2 – Level 1 Assessment

UTILITY PROFILE
Silver Lake is a mid-sized community water system that supplies treated ground water to approximately 24,200 people. It collects 25 routine samples per month.

DESCRIPTION OF THE PROBLEM
The system received a notice of violation for failing to take all of the required repeat samples after a total coliform-positive sample was detected, triggering the system to have a Level 1 assessment.

ASSESSMENT AND CORRECTIVE ACTION
Upon thorough inspection of the distribution system, an air release valve was found submerged in a flooded valve vault. A permanent sump pump will be installed in the vault based on a schedule approved by the State. Shock chlorination measures were performed in accordance with State guidelines on the portion of the line where the air release valve was located.

CONCEPT EXAMPLE NO. 2
Level 1 Assessment Form

System Name: **Silver Lake**	Source Water: **Ground Water**	PWSID # **2345671**
System Type: **CWS**	Population Served: **24,200**	PWS Address:
Operator in Responsible Charge (ORC): **J. Troy**	Phone: **012-345-6789**	**123 Anyway St., Silver Lake, MI 10000**
City, State: **Silver Lake, MI**		
County: **Hamilton**		
Person that collected TC samples if different than ORC: **B. Black, CDE Labs**	Phone: **123-456-7890**	
Address, City, State, Zip: **111 First St., Gold Water, MI 20000**		
Date Assessment Completed: **02/12/2010**		

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1. Evaluate sample site. -condition or location of tap -regular use of connection	✓	**No**		
2. Sample protocol followed and reviewed. -flush tap -remove aerator -no swivel -fresh sample bottles -sample storage acceptable	✓	**No**		
3. Have any of the following occurred at relevant facilities prior to the collection of TC samples? -any interruptions in the treatment process -any reported loss of pressure events (5 psi) -operation and maintenance activities that could have introduced total coliform -reported vandalism and/or unauthorized access to facilities -visible indicators of unsanitary conditions reported -Has there been a fire fighting event, flushing operation, sheared hydrant, etc.	✓	**No**		
4. Have there been any recent operational changes to the system? -sources introduced -treatment or operational changes -potential sources of contamination	✓	**No**		
5. Distribution System -system pressure -cross connection -pump station -air relief valves -fire hydrants or blow off -breaks -repairs	✓	**Yes**	Visual inspection of distribution system conducted on 2/11/10 revealed a potential contamination source at end of distribution system. An air release valve was found submerged in a flooded vault.	Sump pump to be installed at potential contamination site on 2/20/10. State approved corrective action beyond the 30-day period. Shock chlorination performed in accordance with State guidelines on portion of water line where air valve is located.

CONCEPT EXAMPLE NO. 2
Level 1 Assessment Form

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
6. Storage Tank -screens -security -access opening -condition of tank -vent -drain overflow -pressure tank -O&M	✓	**No**		
7. Treatment Process -interruptions -POE/POU -softeners -O&M	✓	**No**		
8. Source – Well -sanitary seal -vent screened -air gap -cross connection -security -pump to waste line	✓	**No**		
9. Source – Spring -condition of spring development -condition of spring box -security	**N/A**			
10. Source - Surface Water Supply -heavy rainfall -rapid snowmelt	**N/A**			

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: **Adam Lockland** Date: **02-12-2010**
Signature:

Reserved for State

1.	Assessment has been successfully completed.	
2.	Likely reason for total coliform-positive occurrence is established.	
3.	System has corrected the problem.	
4.	Was a reset requested and / or granted? – Rationale	
5.	Name of State reviewer:	

Example No. 3 – Level 1 Assessment

UTILITY PROFILE
Eagle Cliff is a community water system that receives its water from a spring source and serves 5,500 people. It collects 6 routine samples per month.

DESCRIPTION OF THE PROBLEM
In July 2009, the routine sample and one of its associated repeat samples both came back total coliform-positive triggering a Level 1 assessment.

ASSESSMENT AND CORRECTIVE ACTION
Upon inspection of the distribution system piping, small factures were found in the water main leading from the spring source to a water tank. The piping was replaced and additional samples were taken to determine whether coliforms were still present in the system. The results came back negative.

CONCEPT EXAMPLE NO. 3
Level 1 Assessment Form

System Name: **Eagle Cliff**	Source Water: **Spring**	PWSID # **3456712**
System Type: **CWS**	Population Served: **5,500**	PWS Address:
Operator in Responsible Charge (ORC): **F. Langdon**	Phone: **012-345-6789**	**456 Anyway St., Eagle Cliff, AL 10000**
City, State: **Eagle Cliff, AL**		
County: **Hoover**		
Person that collected TC samples if different than ORC: **C. Heart**	Phone: **123-456-7890**	
Address, City, State, Zip: **333 Third St., Eagle Cliff, AL 10000**		
Date Assessment Completed: **9/1/2009**		

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1. Evaluate sample site. -condition or location of tap -regular use of connection	✓	**No**		
2. Sample protocol followed and reviewed. -flush tap -remove aerator -no swivel -fresh sample bottles -sample storage acceptable	✓	**No**		
3. Have any of the following occurred at relevant facilities prior to the collection of TC samples? -any interruptions in the treatment process -any reported loss of pressure events (5 psi) -operation and maintenance activities that could have introduced total coliform -reported vandalism and/or unauthorized access to facilities -visible indicators of unsanitary conditions reported -Has there been a fire fighting event, flushing operation, sheared hydrant, etc.	✓	**No**		
4. Have there been any recent operational changes to the system? -sources introduced -treatment or operational changes -potential sources of contamination	✓	**No**		
5. Distribution System -system pressure -cross connection -pump station -air relief valves -fire hydrants or blow off -breaks -repairs	✓	**Yes**	Small fractures detected in raw water line from spring to tank.	Raw water line replacement completed on 8/30/2009
6. Storage Tank -screens -security -access opening -condition of tank -vent -drain overflow -pressure tank -O&M	✓	**No**		

CONCEPT EXAMPLE NO. 3
Level 1 Assessment Form

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
7. Treatment Process -interruptions -POE/POU -softeners -O&M	✓	**No**		
8. Source - Well -sanitary seal -vent screened -air gap -cross connection -security -pump to waste line	**N/A**			
9. Source - Spring -condition of spring development -condition of spring box -security	✓	**No**		
10. Source - Surface Water Supply -heavy rainfall -rapid snowmelt	**N/A**			

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: **Michael Taylor** Date: **09-01-2009**
Signature:

Reserved for State

1.	Assessment has been successfully completed.	
2.	Likely reason for total coliform-positive occurrence is established.	
3.	System has corrected the problem.	
4.	Was a reset requested and / or granted? – Rationale	
5.	Name of State reviewer:	

Example No. 4 – Level 1 Assessment

UTILITY PROFILE

Eggleston Glen is a large municipal water system that is supplied by a ground water source under the direct influence of surface water (GWUDI). The system treats its water before serving it to its 985,000 customers. It collects over 300 routine samples per month.

DESCRIPTION OF THE PROBLEM

In August 2009, more than 5.0% of the monthly total coliform samples came back positive triggering a Level 1 assessment. Many of the positive samples were in the same general location in the distribution system and in proximity to a large ground storage tank. Several days prior to the collection of the positive samples, the system experienced pressure loss for a period of 4 hours while the media in the GAC filters at one of the plants was being changed out. During this time the tank levels dropped to near empty.

ASSESSMENT AND CORRECTIVE ACTION

Normally stagnant water from the tank entered the distribution system during the pressure loss event causing the total coliform-positive results. The tank was taken off-line, cleaned and shock chlorinated in accordance with State guidelines before putting it back on service. The distribution system near the tank was also flushed to improve water turnover.

CONCEPT EXAMPLE NO. 4
Level 1 Assessment Form

System Name: **Eggleston Glen**	Source Water: **GWUDI**	PWSID # **4567123**
System Type: **CWS**	Population Served: **985,000**	PWS Address: **123 Anyway St., Eggleston Glen, CO 10000**
Operator in Responsible Charge (ORC): **J. Griffin**	Phone: **012-345-6789**	
City, State: **Eggleston Glen, CO**		
County: **Hoover**		
Person that collected TC samples if different than ORC: **V. Lewis, GHG Labs**	Phone: **123-456-7890**	
Address, City, State, Zip: **444 Fourth St., Littletown, CO 20000**		
Date Assessment Completed: **8/28/2009**		

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1. Evaluate sample site. -condition or location of tap -regular use of connection	✓	**No**		
2. Sample protocol followed and reviewed. -flush tap -remove aerator -no swivel -fresh sample bottles -sample storage acceptable	✓	**No**		
3. Have any of the following occurred at relevant facilities prior to the collection of TC samples? -any interruptions in the treatment process -any reported loss of pressure events (5 psi) -operation and maintenance activities that could have introduced total coliform -reported vandalism and/or unauthorized access to facilities -visible indicators of unsanitary conditions reported -Has there been a fire fighting event, flushing operation, sheared hydrant, etc.	✓	**Yes**	Loss of system pressure for 4 hours while changing media in GAC filters. Tank level dropped to near empty. This may have allowed "old" water to enter the system from system tank.	Distribution system flushed on 8/15/2009, especially near the tank to improve turnover. Tank was taken off-line, cleaned and shock chlorinated in accordance with State guidelines before putting it back on service. Chlorine will be checked at sample location at least two times per month.
4. Have there been any recent operational changes to the system? -sources introduced -treatment or operational changes -potential sources of contamination	✓	**No**		
5. Distribution System -system pressure -cross connection -pump station -air relief valves -fire hydrants or blow off -breaks -repairs	✓	**No**		

CONCEPT EXAMPLE NO. 4
Level 1 Assessment Form

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
6. Storage Tank -screens -security -access opening -condition of tank -vent -drain overflow -pressure tank -O&M	✓	**No**		
7. Treatment Process -interruptions -POE/POU -softeners -O&M	✓	**No**		
8. Source - Well -sanitary seal -vent screened -air gap -cross connection -security -pump to waste line	✓	**Yes**	**See item No. 1**	
9. Source - Spring -condition of spring development -condition of spring box -security	✓	**No**		
10. Source - Surface Water Supply -heavy rainfall -rapid snowmelt	**N/A**			

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: **John Gilmore** Date: **08-28-2009**
Signature:

Reserved for State

1. Assessment has been successfully completed.
2. Likely reason for total coliform-positive occurrence is established.
3. System has corrected the problem.
4. Was a reset requested and / or granted? – Rationale
5. Name of State reviewer:

Example No. 5 – Level 2 Assessment

UTILITY PROFILE
Warsaw Falls is a community water system that gets its water from ground water sources. It serves a population of 2,550 people and collects 3 routine samples every month.

DESCRIPTION OF THE PROBLEM
In January 2010, the system had an *E. coli* MCL violation (a routine sample that was *E. coli*-positive followed by a repeat sample that was total coliform-positive) that triggered a Level 2 assessment.

ASSESSMENT AND CORRECTIVE ACTION
The Level 2 assessment revealed unsanitary conditions around one particular well that was located in a parking lot, which may or may not have been the source of the contamination. The system operator noted the need to re-locate or significantly improve the well due to its location and the poor condition of the well casing. The system coordinated with the State to develop interim measures and to work out a schedule to perform the remaining corrective action beyond the 30-day period. The pressure tank was also recently replaced but was not believed to be the source of the contamination as the whole system was shock chlorinated after the tank was replaced.

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

System Name: **Warsaw Falls Recreation Center**	Source Water: **Ground Water**	PWSID # **5671234**
System Type: **CWS**	Population Served: **2,550**	PWS Address: **123 Anyway St., Warsaw Falls, FL 10000**
Operator in Responsible Charge (ORC): **Peter Garrison**	Phone: **012-345-6789**	
City, State: **Warsaw Falls, FL**		
County: **Ford**		
Person that collected TC samples if different than ORC: **J. Smith, ABC Labs**	Phone: **123-456-7890**	
Address, City, State, Zip: **012 Main St., Bigtown, FL 11111**		
Date Assessment Completed: **02/10/2010**		

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1.	**Evaluate sample site**				
a.	What is the condition of the tap? **(Provide comments)**	**Good**			
b.	What is the location of the tap? **(Provide comments)**	**Good**			
c.	What is the regular use of the connection? **(Provide comments)**	**Raw water tap for sample collection**			
d.	Have there been any plumbing changes or construction? If yes, when and what was the repair or change?	✓	**No**		
e.	Have there been any plumbing breaks or failure? If yes, when?	✓	**No**		
f.	List any identified cross connections after the service connection or in premise plumbing. **(Provide comments)**	**None**			
g.	Were all of the backflow prevention devices present, operational and maintained?	✓	**No**		
h.	Were there any low pressure events or changes in water pressure after the service connection or in the premise plumbing? If yes, when?	✓	**No**		

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
i.	Are there any treatment devices after the service connection or in premise? **(Circle response, if applicable)**	Point of Entry (POE)		Point of Use (POU)	
j.	Other comments on sample site?				
2.	**Sample protocol followed and reviewed**	**None**			
a.	Flush tap, remove aerator, no swivel, fresh sample bottles, sample storage acceptable	✓	**No**		
3.	**Have any of the following occurred at relevant facilities prior to the collection of TC samples?**				
a.	Were there any operation and maintenance activities that could have introduced total coliforms?	✓	**No**		
b.	Have there been any interruptions in the treatment process?	✓	**No**		
c.	Has the system lost pressure to less than 5 psi?	✓	**No**		
d.	Have there been any vandalism and/or unauthorized access to facilities?	✓	**No**		
e.	Are there any visible indicators of unsanitary conditions observed?	✓	**Yes**	**Unsanitary conditions around well including garbage and parking lot run-off.**	**See item 8.**
f.	Have there been any analytical results or any additional samples collected, including source samples which were positive (not for compliance)?	✓	**No**		
g.	Have there been any community illness suspected of being waterborne (e.g., Does the community public health official indicate that an outbreak has occurred.)	✓	**No**		
h.	Did the water system receive any TCR monitoring violations in the past 12 months? If yes, when.	✓	**No**		
i.	What was the most recent date on which satisfactory total coliform samples were taken?	Date: **Dec 2009**			
j.	Have there been a fire fighting event, flushing operation, sheared hydrant, etc.	✓	**No**		
k.	Other comments on records and maintenance?	**None**			

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
4.	**Have there been any recent treatment or operational changes?**				
a.	Have any inactive sources recently been introduced into the system (e.g., auxiliary systems)?	✓	**No**		
b.	Have there been any new sources introduced into the system?	✓	**No**		
c.	Is there evidence of any potential sources of contamination (main breaks, low pressure, high turbidity, loss of disinfection, etc.)?	✓	**No**		
5.	**Distribution System**				
a.	System pressure: Is there evidence that the system experienced low or negative pressure? If yes, when?	✓	**No**		
b.	List any identified cross connections.	✓	**No**		
c.	Pump station: Are there any sanitary defects in the pump station? Are pump(s) operable?	✓	**No**		
d.	Last pump maintenance/service date. **(Respond if applicable)**	Date: **12/2006**		Maintenance Performed? **Mechanical seal replaced**	
e.	Air relief valves: Is the valve vault subject to flooding or does the vent terminate below grade?	✓	**No**		
f.	Fire hydrant/blow off: Are any located in an area with a high water table or pits?	✓	**No**		
g.	Is the distribution system secured to prevent unauthorized access?	✓	**No**		
h.	Are the backflow prevention devices at high risk sites present, operational and maintained?	✓	**No**		
i.	Have there been any water main repairs or additions? If yes when, and what was the repair or addition?	✓	**No**		
j.	Have there been any water main breaks? If yes, when?	✓	**No**		
k.	Was there any scheduled flushing of the distribution system? If yes, when?	✓	**No**		
l.	Is there any evidence of intentional contamination in the distribution system?	✓	**No**		
m	Other comments on the distribution information.	**None**			

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
6.	**Storage Facilities**				
a.	Are the overflow and vents properly screened?	✓	**No**		
b.	Is the facility secured to prevent unauthorized access?	✓	**No**		
c.	Does the access opening have the proper gasket and seal tightly?	✓	**No**		
d.	Could the physical condition of tank be a source of contamination?	✓	**No**	**The pressure tank was recently replaced.**	**Whole system was shock chlorinated after the tank replacement. It is not believed there is correlation between the bacteria found and the work on this tank.**
e.	Is the vent turned down and maintaining an approved air gap at the termination point?	✓	**No**		
f.	Does the drain/overflow line terminate at a minimum of 12" air gap?	✓	**No**		
g.	If present, is the pressure tank maintaining an appropriate minimum pressure?	✓	**No**		
h.	Has proper O&M been performed?	✓	**No**		
i.	Was there any observed physical deterioration of the tank?	✓	**No**		
j.	Were there any observed leaks?	✓	**No**		
k.	Is there any evidence of intentional contamination at the storage tank?	✓	**No**		
l.	Has there been any facility maintenance (i.e. painting/coating)? If yes, when?	✓	**No**		
m	Is facility maintenance occurring per appropriate schedule?	✓	**No**		
n.	Does the tank "float" on the distribution system or are there separate inlet and outlet lines?	✓	**No**		
o.	What is the measured chlorine residual (total/free) of the water exiting the storage tank today?	Residual **N/A**			
p.	Are there any unsealed openings in the storage facility such as access doors, vents or joints?	✓	**No**		
q.	Other comments on the storage system	**None**			

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
7.	**Treatment Process. (If applicable)**				
a.	Treatment devices operational and maintained?	**N/A**			
b.	Is there any recent installation or repair of treatment equipment?	**N/A**			
c.	Were there any recent changes in the treatment process? If yes, when, what was the change?	**N/A**			
d.	Were there any interruptions of treatment (lapses in chemical feed, turbidity excursions, disinfection)? If yes which part, when and for how long?	**N/A**			
e.	What is the free chlorine residual measured immediately downstream from the point of application?	**Residual: N/A**			
f.	Did a review of the filter turbidity profiles reveal any anomalies?	**N/A**			
g.	Were there any failures to meet the C x T calculations?	**N/A**			
h.	Were the flow rates above the rated capacity?	**N/A**			
i.	Were there any anomalies on the settled water turbidities?	**N/A**			
j.	Other comments on the treatment system.	**None**			
8.	**Source – Well**				
a.	Is the sanitary seal intact?	✓	**No**		
b.	Is the vent screened?	✓	**No**		
c.	Does the vent and pump to waste terminate in an approved air gap?	✓	**No**		
d.	Are there any unprotected cross connections at the wellhead?	✓	**No**		
e.	How is the well used? **(Circle if applicable)**	Primary	Backup	Emergency Not a PWS	Not Drinking Water
f.	How far does the casing extend above grade?	Height **14 inches**		Comments:	
g.	Is the well cap vented?	✓	**No**		

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
h.	Is there evidence of standing water near the wellhead?	✓	**Yes**	**After heavy rain events, there is standing water for a day or two.**	
i.	Is the wellhead secured to prevent unauthorized access?	✓	**No**		
j.	Have there been any sewer spills, source water spills or other disturbances?	✓	**No**		
k.	Other comments on the well system. (Are there aspects of well construction and operation that would bear on observed positives?)			**Well needs significant rehabilitation or relocation, requiring more than 30 days. Coordinated with district engineer to develop schedule and interim measures. Well will be kept off-line to greatest extent possible, with the State to be notified and chlorine disinfection to be applied at 2 mg/L whenever well is put on-line. Engineering feasibility study and corrective action recommendation and proposed completion schedule due to State by 3/10/10. Corrective action and completion schedule approved by State by 3/25/10.**	
9.	**Source – Spring**				
a.	What is the condition of the spring development?	**N/A**			
b.	What is the condition of the spring box?	**N/A**			
c.	Is the spring secured to prevent unauthorized access?	**N/A**			
d.	Other comments on the spring system.	**None**			
10.	**Source - Surface Water Supply**				
a.	Have there been any sewer spills, source water spills or other disturbances?	**N/A**			
b.	Have there been any algal blooms?	**N/A**			
c.	Has source water turnover occurred?	**N/A**			
d.	Other source water comments	**None**			

CONCEPT EXAMPLE NO. 5
Level 2 Assessment Form

Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
11. Environmental Events				
a. Has there been heavy rainfall?	✓	**Yes**	**See Item 8.**	
b. Has there been any rapid snow melt or flooding?	✓	**No**		
c. Have there been changes in available source water (e.g., significant drop in water table, well levels, reservoir capacity, etc.)	✓	**No**		
d. Have there been any interruptions to electrical power?	✓	**No**		
e. Have there been any extremes in heat or cold?	✓	**No**		

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: **Chris Weaver** Date: **02/03/2010**
Signature:

Reserved for State

1. Assessment has been successfully completed. ☐ Name of State Reviewer: _____

Example No. 6 – Level 2 Assessment

UTILITY PROFILE
Chimney Bluffs Community Church is a transient non-community water system that gets its water from a ground water source. It serves a population of about 200 people and takes a routine sample every quarter.

DESCRIPTION OF THE PROBLEM
The system had two total coliform-positive samples in July 2009 and again in March 2010 triggering a Level 2 assessment (2 Level 1 assessments within a rolling 12-month period). Since the system does not have anyone approved by the State to perform a Level 2 assessment, the Operator in Responsible Charge (ORC) identified an assessor approved by the State from the State website.

ASSESSMENT AND CORRECTIVE ACTION
The system noted three possible sources of contamination: 1) inadequate/improper chlorination of an in-line conditioner after replacement of pressure tank and plumbing; 2) need for replacement of filters in the reverse osmosis system; and 3) use of a swivel faucet at the sampling site. The system suspected the first possible source as the cause of the contamination and chlorinated the in-line conditioner in March 2010. The old swivel faucet was also replaced.

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

System Name: **Chimney Bluffs Community Church**	Source Water: **Ground Water**	PWSID # **6712345**
System Type: **TNCWS**	Population Served: **200**	PWS Address:
Operator in Responsible Charge (ORC): **Mary Spelling**	Phone: **012-345-6789**	**123 Anyway St., Chimney Bluffs, AZ**
City, State: **Chimney Bluffs, AZ**		**1000**
County: **Jackson**		
Person that collected TC samples if different than ORC: **A. Brown, ABC Labs**	Phone: **123-456-7890**	
Address, City, State, Zip: **7556 Desert Ave, Tempe, AZ 99999**		
Date Assessment Completed: **04/06/2010**		

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
1.	**Evaluate sample site**				
a.	What is the condition of the tap? **(Provide comments)**	**Fair**			
b.	What is the location of the tap? **(Provide comments)**	**Church rectory**			
c.	What is the regular use of the connection? **(Provide comments)**	**Potable water source for the rectory**			
d.	Have there been any plumbing changes or construction? If yes, when and what was the repair or change?	✓	**No**		
e.	Have there been any plumbing breaks or failure? If yes, when?	✓	**No**		
f.	List any identified cross connections after the service connection or in premise plumbing. **(Provide comments)**	**In-line water conditioner**			
g.	Were all of the backflow prevention devices present, operational and maintained?	✓	**No**		
h.	Were there any low pressure events or changes in water pressure after the service connection or in the premise plumbing? If yes, when?	✓	**No**		
i.	Are there any treatment devices after the service connection or in premise? **(Circle response, if applicable)**			Point of Entry (POE)	Point of Use (POU)

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
j.	Other comments on sample site?	**None**			
2.	**Sample protocol followed and reviewed**				
a.	Flush tap, remove aerator, no swivel, fresh sample bottles, sample storage acceptable	✓	**Yes**	**Sample site had old swivel faucet.**	**Faucet replaced on 3/30/10.**
3.	**Have any of the following occurred at relevant facilities prior to the collection of TC samples?**				
a.	Were there any operation and maintenance activities that could have introduced total coliforms?	✓	**Yes**	**The pressure tank and plumbing in and around the pump room were recently replaced. System includes an in-line water conditioner. It is unknown if water conditioner was chlorinated or by-passed during the chlorination prior to putting tank and plumbing back in service.**	**Water conditioner chlorinated on 3/30/2010 and put back in service.**
b.	Have there been any interruptions in the treatment process?	✓	**No**		
c.	Has the system lost pressure to less than 5 psi?	✓	**No**		
d.	Have there been any vandalism and/or unauthorized access to facilities?	✓	**No**		
e.	Are there any visible indicators of unsanitary conditions observed?	✓	**No**		
f.	Have there been any analytical results or any additional samples collected, including source samples which were positive (not for compliance)?	✓	**No**		
g.	Have there been any community illness suspected of being waterborne (e.g., Does the community public health official indicate that an outbreak has occurred.)	✓	**No**		
h.	Did the water system receive any TCR monitoring violations in the past 12 months? If yes, when.	✓	**Yes**	**July 2009**	
i.	What was the most recent date on which satisfactory total coliform samples were taken?	Date: **Dec 2009**			
j.	Have there been a fire fighting event, flushing operation, sheared hydrant, etc.	✓	**No**		
k.	Other comments on records and maintenance?	**None**			

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
4.	**Have there been any recent treatment or operational changes?**				
a.	Have any inactive sources recently been introduced into the system (e.g., auxiliary systems)?	✓	**No**		
b.	Have there been any new sources introduced into the system?	✓	**No**		
c.	Is there evidence of any potential sources of contamination (main breaks, low pressure, high turbidity, loss of disinfection, etc.)?	✓	**No**		
5.	**Distribution System**				
a.	System pressure: Is there evidence that the system experienced low or negative pressure? If yes, when?	✓	**No**		
b.	List any identified cross connections.	✓	**No**		
c.	Pump station: Are there any sanitary defects in the pump station? Are pump(s) operable?	✓	**No**		
d.	Last pump maintenance/service date. **(Respond if applicable)**	Date: **N/A**		Maintenance Performed?	
e.	Air relief valves: Is the valve vault subject to flooding or does the vent terminate below grade?	✓	**No**		
f.	Fire hydrant/blow off: Are any located in an area with a high water table or pits?	✓	**No**		
g.	Is the distribution system secured to prevent unauthorized access?	✓	**No**		
h.	Are the backflow prevention devices at high risk sites present, operational and maintained?	✓	**No**		
i.	Have there been any water main repairs or additions? If yes when, and what was the repair or addition?	✓	**No**		
j.	Have there been any water main breaks? If yes, when?	✓	**No**		
k.	Was there any scheduled flushing of the distribution system? If yes, when?	✓	**No**		
l.	Is there any evidence of intentional contamination in the distribution system?	✓	**No**		
m	Other comments on the distribution information.	**None**			

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
6.	**Storage Facilities**				
a.	Are the overflow and vents properly screened?	**N/A**			
b.	Is the facility secured to prevent unauthorized access?	**N/A**			
c.	Does the access opening have the proper gasket and seal tightly?	**N/A**			
d.	Could the physical condition of tank be a source of contamination?	**N/A**			
e.	Is the vent turned down and maintaining an approved air gap at the termination point?	**N/A**			
f.	Does the drain/overflow line terminate at a minimum of 12" air gap?	**N/A**			
g.	If present, is the pressure tank maintaining an appropriate minimum pressure?	**N/A**			
h.	Has proper O&M been performed?	**N/A**			
i.	Was there any observed physical deterioration of the tank?	**N/A**			
j.	Were there any observed leaks?	**N/A**			
k.	Is there any evidence of intentional contamination at the storage tank?	**N/A**			
l.	Has there been any facility maintenance (i.e. painting/coating)? If yes, when?	**N/A**			
m.	Is facility maintenance occurring per appropriate schedule?	**N/A**			
n.	Does the tank "float" on the distribution system or are there separate inlet and outlet lines?	**N/A**			
o.	What is the measured chlorine residual (total/free) of the water exiting the storage tank today?	Residual **N/A**			
p.	Are there any unsealed openings in the storage facility such as access doors, vents or joints?	**N/A**			
q.	Other comments on the storage system	**None**			

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
7.	**Treatment Process. (If applicable)**				
a.	Treatment devices operational and maintained?	✓	**No**		
b.	Is there any recent installation or repair of treatment equipment?	✓	**Yes**	**The filters were replaced in the reverse osmosis system that feeds the faucets connected to the rectory and the kitchen.**	**Filter replacement has never been the source of contamination in the past and is not believe to be related to this event.**
c.	Were there any recent changes in the treatment process? If yes, when, what was the change?	✓	**No**		
d.	Were there any interruptions of treatment (lapses in chemical feed, turbidity excursions, disinfection)? If yes which part, when and for how long?	✓	**No**		
e.	What is the free chlorine residual measured immediately downstream from the point of application?	**Residual: N/A**			
f.	Did a review of the filter turbidity profiles reveal any anomalies?	**N/A**			
g.	Were there any failures to meet the C x T calculations?	**N/A**			
h.	Were the flow rates above the rated capacity?	**N/A**			
i.	Were there any anomalies on the settled water turbidities?	**N/A**			
j.	Other comments on the treatment system.	**None**			
8.	**Source – Well**				
a.	Is the sanitary seal intact?	✓	**No**		
b.	Is the vent screened?	✓	**No**		
c.	Does the vent and pump to waste terminate in an approved air gap?	✓	**No**		
d.	Are there any unprotected cross connections at the wellhead?	✓	**No**		
e.	How is the well used? **(Circle if applicable)**	Primary Backup Emergency Not a PWS Not Drinking Water			
f.	How far does the casing extend above grade?	Height _____		Comments:	

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
g.	Is the well cap vented?	✓	**No**		
h.	Is there evidence of standing water near the wellhead?	✓	**No**		
i.	Is the wellhead secured to prevent unauthorized access?	✓	**No**		
j.	Have there been any sewer spills, source water spills or other disturbances?	✓	**No**		
k.	Other comments on the well system. (Are there aspects of well construction and operation that would bear on observed positives?)			**Well needs significant rehabilitation or relocation, requiring more than 30 days. Coordinated with district engineer to develop schedule and interim measures. Well will be kept off-line to greatest extent possible, with the State to be notified and chlorine disinfection to be applied at 2 mg/L whenever well is put on-line. Engineering feasibility study and corrective action recommendation and proposed completion schedule due to State by 3/10/10. Corrective action and completion schedule approved by State by 3/25/10.**	
9.	**Source – Spring**				
a.	What is the condition of the spring development?	**N/A**			
b.	What is the condition of the spring box?	**N/A**			
c.	Is the spring secured to prevent unauthorized access?	**N/A**			
d.	Other comments on the spring system.	**None**			
10.	**Source - Surface Water Supply**				
a.	Have there been any sewer spills, source water spills or other disturbances?	**N/A**			
b.	Have there been any algal blooms?	**N/A**			
c.	Has source water turnover occurred?	**N/A**			

CONCEPT EXAMPLE NO. 6
Level 2 Assessment Form

	Questions	Reviewed and checked? (Type "✓" if completed or "N/A")	Issue(s) found? (Y/N)	Issue Description	Corrective Action Taken (Including Date)
d.	Other source water comments	**None**			
	Environmental Events				
a.	Has there been heavy rainfall?	✓	**No**		
b.	Has there been any rapid snow melt or flooding?	✓	**No**		
c.	Have there been changes in available source water (e.g., significant drop in water table, well levels, reservoir capacity, etc.)	✓	**No**		
d.	Have there been any interruptions to electrical power?	✓	**No**		
e.	Have there been any extremes in heat or cold?	✓	**No**		

Note: Form to be completed based on data and documents available to the PWS operator in charge, maintained on file and returned to the Primacy Agency within 30 days of triggering the assessment.

Additional Comments:

Print name of person completing form: **John Marshall** Date: **04/08/2010**
Signature:

Reserved for State

1. Assessment has been successfully completed. ☐ Name of State Reviewer: _____

APPENDIX D. Industry Standards for Operating a Public Water System

Presented in this appendix is a list of standards, manuals and other reference materials that may be useful to public water systems when implementing the corrective actions discussed in **Chapter 5** of this document. This is not an exhaustive list. Systems should check with their States to determine if there are different or additional standards they should be adhering to.

List of Standards and Manuals

The American Water Works Association (AWWA) has developed standards based on the collective knowledge of its membership. The information contained in these standards has been collected and improved over many years and has gone through rigorous review and development. AWWA Standards are typically minimum best practices and help to ensure that a product (e.g., pipes, fittings, meters, etc.) or a process (e.g., main flushing, main installation, etc.) described in a standard will provide satisfactory service.

Standard Number	**Topic**
AWWA A100	Water Wells
AWWA B300	Hypochlorites
AWWA B301	Liquid Chlorine
AWWA C104/A21.4	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C116/A21.16	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
AWWA C150/A21.50	Thickness Design of Ductile-Iron Pipe-Erratum: 02/2003
AWWA C151/A21.51	Ductile-Iron Pipe, Centrifugally Cast, for Water- Erratum
AWWA C153/A21.53	Ductile-Iron Compact Fittings, for Water Service
AWWA C200	Steel Water Pipe - 6 in. (150 mm) and Larger
AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger - Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm)

Standard Number	Topic
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
AWWA C218	Coating the Exterior of Aboveground Steel Water Pipelines and Fittings-Third Edition
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings-First Edition
AWWA C224	Two-Layer Nylon-11-Based Polyamide Coating System for the Interior and Exterior of Steel Water Pipe, Connections, Fittings, and Special Sections
AWWA C225	Fused Polyolefin Coating systems for the Exterior of Steel Water Pipelines-First Edition
AWWA C300	Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C301	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type-Erratum - January 2000
AWWA C302	Reinforced Concrete Pressure Pipe, Noncylinder Type
AWWA C303	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C304	Design of Prestressed Concrete Cylinder Pipe
AWWA C400	Asbestos-Cement Pressure Pipe, 4 in. Through 16 in. (100 mm Through 400 mm), for Water Distribution Systems
AWWA C401	The Selection of Asbestos-Cement Pressure Pipe, 4 in. Through 16 in.(100 mm Through 400 mm), for Water Distribution Systems
AWWA C402	Asbestos-Cement Transmission Pipe, 18 in. Through 42 in. (450 mm Through 1,050 mm), for Water Supply Service
AWWA C403	Selection of Asbestos-Cement Transmission Pipe, Sizes 18 in. Through 42 in. (450 mm Through 1,050 mm), for Water Supply Service
AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C502	Dry-Barrel Fire Hydrants
AWWA C503	Wet-Barrel Fire Hydrants
AWWA C508	Swing-Check Valves for Waterworks Service, 2-in. Through 24-in. (50-mm Through 600-mm) NPS
AWWA C509	Resilient-Seated Gate Valves for Water Supply Service

Standard Number	Topic
AWWA C512	Air Release, Air/ Vacuum, and Combination Air Valves for Waterworks Service
AWWA C515	Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service-Second Edition
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C602	Cement-Mortar Lining of Water Pipelines in Place - 4 in. (100 mm) and Larger
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water-First Edition
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
AWWA C652	Disinfection of Water-Storage Facilities
AWWA C653	Disinfection of Water Treatment Plants
AWWA C654	Disinfection of Wells
AWWA C700	Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA C701	Cold-Water Meters - Turbine Type, for Customer Service
AWWA C702	Cold-Water Meters - Compound Type
AWWA C703	Cold-Water Meters - Fire Service Type
AWWA C704	Propeller-Type Meters for Waterworks Applications
AWWA C706	Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C707	Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C708	Cold-Water Meters - Multijet Type
AWWA C710	Cold-Water Meters - Displacement Type, Plastic Main Case
AWWA C712	Cold-Water Meters - Singlejet Type-First Edition
AWWA C713	Cold-Water Meters Fluidic-Oscillator Type-First Edition
AWWA C800	Underground Service Line Valves and Fittings
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in.(100 mm Through 300 mm), for Water Distribution
AWWA C901	Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. (13 mm) Through 3 in. (76 mm), for Water Service
AWWA C903	Polyethylene-Aluminum-Polyethylene & Cross-linked Polyethylene-Aluminum-Cross-linked Polyethylene Composite Pressure Pipes, 1/2 In. (12 mm) Through 2 In. (50 mm), for Water Service
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches Through 48 Inches (350mm Through 1,200mm), for Water Transmission and Distribution
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) Through 63 in. (1,575 mm), for Water Distribution and Transmission
AWWA C907	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA C909	Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 in. Through 12 in. (100 mm Through 600 mm), for Water Distribution

Standard Number	Topic
AWWA C950	Fiberglass Pressure Pipe
AWWA D100	Welded Steel Tanks for Water Storage
AWWA D102	Coating Steel Water-Storage Tanks
AWWA D103	Factory-Coated Bolted Steel Tanks for Water Storage
AWWA D104	Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks
AWWA D110	Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks
AWWA D115	Circular Prestressed Concrete Water Tanks with Circumferential Tendons-First Edition
AWWA D130	Flexible-Membrane Materials for Potable Water Applications
AWWA G100	Water Treatment Plant Operation and Management-First Edition
AWWA G200	Distribution Systems Operation and Management
Manual Number	**Topic**
AWWA M2	Instrumentation and Control, 3rd ed. (2001)
AWWA M14	Recommended Practice for Backflow (2004)
AWWA M17	Installation, Field Testing, and Maintenance of Fire Hydrants, 4th ed. (2006)
AWWA M20	Water Chlorination and Chloramination Practices and Principles, 2nd ed. (2006)
AWWA M28	Rehabilitation of Water Mains, 2nd ed. (2001)
AWWA M42	Steel Water Storage Tanks (1998)
AWWA M44	Distribution Valves: Selection, Installation, Field Testing, and Maintenance, 2nd ed. (2006)
AWWA M56	Fundamentals and Control of Nitrification in Chloraminated Drinking Water Distribution Systems (2006)

Other Reference Materials

- Local plumbing codes – Systems should check with their municipality or State if there are local plumbing codes they should be following.
- "Recommended Standards for Water Works" (also known as the "10 States Standards") (Great Lakes et al. 2007)