Total Coliform-Positive Well Water Test: Now What

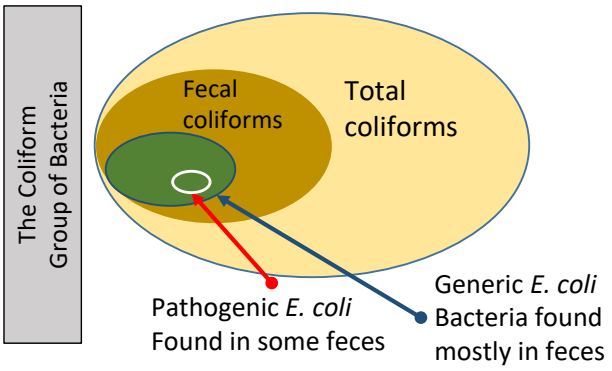


Figure from Produce Safety Alliance Grower Training Module 5.1

Summary of Main Points

- Agricultural water used during harvest and postharvest should be the microbial equivalent of drinking water.
- Protected ground water normally has no detectable coliform bacteria in 100 mL. Presence of total coliforms indicates vulnerability to surface intrusion. Presence of generic *E. coli* indicates that feces has intruded.
- Corrective actions in response to total coliform-positive well water can vary; depending on the use of the water it may be important to understand and address the conditions that led to intrusion.
- If the total coliforms in the water include generic *E. coli,* corrective action is a priority; immediately stop use as drinking water or in contact with produce during harvest and postharvest, then find and resolve the cause.

You might sample your farm's well water and have it tested at the lab for total coliform bacteria. Finding coliforms in your well water is a warning sign that the water source is not protected from contamination. It might become, or already is, contaminated with pathogens that can make people sick. So, what do you do when a water test result comes back positive?

Agricultural water samples are often tested for total coliforms and generic *E. coli* at the same time. The importance of positive test results depends on which test was positive, and how you use the water. Regulatory requirements for agricultural water and drinking water are both important (see *What the Regulations Include* call-out box) because some requirements and guidance for agricultural water are based on meeting the USEPA microbial standards for drinking water quality (see *What Food Safety Audits Include* call-out box).

What the Regulations Include:

Agricultural Water: The Food Safety Modernization Act (FSMA), Produce Safety Rule (PSR) does not mention total coliform bacteria. FSMA PSR standards are based on generic *E. coli* concentration, because they are considered the best available indicator of fecal contamination.

Drinking Water: The U. S. Environmental Protection Agency (USEPA) National Primary Drinking Water Regulations (NPDWR) Revised Total Coliform Rule (RTCR) requires total coliform testing and includes a maximum contaminant level for generic *E. coli*. Under RTCR, detection of total coliforms in a drinking water sample requires follow-up to confirm whether the total coliforms detected include *E. coli*. A total coliform-positive result from regulated drinking water also triggers more system monitoring and evaluation.

Resources:

FSMA Final Rule on Produce Safety § 112.44(a)**:**
www.ecfr.gov/current/title-21/part-112/subpart-E#p-112.44(a)

USEPA Revised Total Coliform Rule: A Quick Reference Guide:
nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100K9MP.txt

December 2023

North Central Region
Center for FSMA Training, Extension and Technical Assistance

Total Coliform-Positive Results

If you have total coliforms in your water, they likely came from near the earth's surface, not from deep underground. That is important because it means that other things that are near the surface, like feces, can also get into your water. Total coliform bacteria themselves are mostly harmless to people and are found just about anywhere on land or in surface water. This is why the total coliform test is more meaningful for ground water than for surface water.

Protected ground water has been underground, often for many years, and should not carry total coliform bacteria. Treated drinking water (e.g., municipal water) also should not carry total coliform bacteria. Finding total coliforms in well water or municipal water means that the water was not fully protected either in the aquifer, while being taken from the aquifer, in storage, or in the water distribution system.

Generic *E. coli*-Positive Results

Having generic *E. coli* in your water means that the water has probably been contaminated with feces from people or warm-blooded animals. The animal might have defecated directly in the water, or the feces might have been carried to the water by runoff, on equipment, or by other pathways. A positive *E. coli* test means the water is unsafe for many uses because water with feces can also have fecal-oral pathogens like norovirus or *Salmonella* that make people sick.

Because *E. coli* is a fecal indicator, there are regulatory implications to positive results. The water must not be used for drinking and must not be used for harvest or postharvest handling of most fresh produce. This is because RTCR has a "no-detect" *E. coli* standard for drinking water and FSMA PSR uses the same standard for agricultural water used during harvest and post-harvest, including hand washing and contact with produce or food-contact surfaces.

What Food Safety Audits Include:

Harvest and post-harvest water:

USDA GAP Standard

3-3 "*Source water used in the packing operation meets the microbial standard for drinking water*"

Harmonized GAP Plus+ Standard:

F-10 Water/Ice Used in the Harvesting and Post-Harvest Operations.

F10.2 Requirement and Procedure read, in part: "*Operation's water use SOP requires that water or ice when applied meets the microbial standards for drinking water, as defined by prevailing regulation. …*"

GLOBALG.A.P. Integrated Farm Assurance Standard:

FV-GFS 30.05 Water Quality

FV 30.05.04 Criteria reads, in part, "*Water (including ice) used during harvest and postharvest activities (cooling, transport, washing, etc.) shall meet the microbial standards for drinking water and shall be handled so as to prevent product contamination. …*"

Preharvest water:

CA Leafy Greens Marketing Agreement (LGMA) Metric:

D1. Routine Verification of Microbial Water Quality

Only type A water may be used for overhead irrigation within a 21-days-to-harvest window. For treated water, "*To maintain its Type A status, water samples must have:*

- *no detectable generic E. coli in at least two (2) of the three (3) samples with a maximum level no greater than (<) 10 MPN in the remaining sample, and*
- *data monitoring for total coliforms at a level no greater than (<) 99 MPN in 100 mL*"

Resources:

USDA Harmonized GAP Plus+ Standard (V.4.0): www.ams.usda.gov/sites/default/files/media/HarmonizedGAPPlus%2BStandardVersion4.0_0.pdf

GLOBALG.A.P Integrated Farm Assurance (IFA) V6: www.globalgap.org/uk_en/for-producers/globalg.a.p./integrated-farm-assurance-ifa/IFA-V6/

California LGMA Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens: lgma-assets.sfo2.digitaloceanspaces.com/downloads/August-2021-CA-LGMA-Metrics_FINAL-v20211208_A11Y.pdf

December 2023

North Central Region
Center for FSMA Training, Extension and Technical Assistance

Required Responses to a Total Coliform-Positive Result in Well Water

Food Safety Audit Guidance for Corrective Actions:

Harvest and post-harvest water:

***USDA GAP Program FAQs**:*

"total coliform no longer has a MCL, however, are now used to trigger an assessment of the system. For the purposes of GAP audits, detectable total coliform in a post-harvest water test would indicate potential contamination and therefore require that the water system be reevaluated following a company's corrective action process."

***GLOBALG.A.P. Integrated Farm Assurance Standard**:*

No specific corrective action for a total coliform-positive result in the guidelines; however, a corrective action should be taken. "*Water analysis shall always be carried out at a frequency according to the results of the risk assessment, with documented actions taken in response to the results of the analysis.*"

Preharvest water:

***California LGMA Guidelines for Treated Type A Water**:*

"If these water samples fail to meet the monitoring criterion (for total coliforms) *perform a root cause analysis and continue to evaluate your irrigation treatment system to identify and correct any failures and continuing to test as described in this step until the water is back in compliance…'* Please go to the document for full guidance in context. This requirement is designed to manage produce safety risk for outdoor leafy greens operations in California (and Arizona) and may not be applicable to other commodities, growing conditions, and regions.

Resources:

USDA GAP Program Water FAQS): www.ams.usda.gov/sites/default/files/media/GAPWATERFAQS.pdf

GLOBALG.A.P Integrated Farm Assurance Guideline for Fruits and Vegetables:

www.globalgap.org/.content/.galleries/documents/220929_IFA_guideline_FV_v6_0_Sep22_en.pdf

California LGMA Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens (page 61)**:**

lgma-ssets.sfo2.digitaloceanspaces.com/downloads/August-2021-CA-LGMA-Metrics_FINAL-v20211208_A11Y.pdf

The FSMA PSR regulation does not stop you from using water that contains total coliform bacteria on produce preharvest, during harvest, or postharvest, as those agricultural water standards in the FSMA PSR are based instead on generic *E. coli*. However, food safety audits can include restrictions or requirements to follow up on a total coliform-positive result in well water or municipal water.

You are not required by regulation or the referenced audit standards to stop use of the water on produce based on a total coliform-positive result. However, the result is valuable information that you should act on. Because of the test result, you know that there is either a vulnerability in the well or water storage and distribution system, or the aquifer that serves as the water source is vulnerable to intrusion. You can expect to be asked what action you took after getting the positive test result in order to reduce risk to produce safety. You might also be asked about the history of the well, and if you have tests from previous years to show if the issue is new or if there is a history of positive test results.

At the time of the most recent document update, there is no FDA guidance and very little history of FSMA PSR inspections covering water quality requirements. This limits our ability to describe expectations about responses a PSR inspector might look for when facing a total coliform-positive result in agricultural water.

Some food safety audit systems include requirements that are consistent with, but might go beyond, the requirements of the FSMA PSR. Example guidance about responses to a total coliform-positive postharvest water sample from food safety audit schemes is provided in the *Food Safety Audit Guidance for Corrective Actions* call-out box.

December 2023

North Central Region
Center for FSMA Training, Extension and Technical Assistance

In general, a farm is expected to have a process they use to evaluate the risk to produce safety posed by total coliform-positive well water in their operation. The process should include understanding the conditions that could allow intrusion, and whether the conditions might also allow intrusion by fecal-oral pathogens. If the farm's evaluation indicates that a corrective action is necessary, then follow up to address those conditions or find other ways to reduce risk to produce safety.

What to Do about a Total Coliform-Positive Result in Well Water

You will want to evaluate risk and decide on corrective actions for your total coliform-positive well water that will protect the safety of produce and the consumers that eat it. The steps you should take depend on how you use the water on your farm. The important thing to keep in mind is the goal to reduce potential for pathogens in the water that you use in contact with fresh produce, especially during harvest and postharvest. Some of these steps might also be valuable for situations involving municipal water.

You might decide to be strategic about how you use your water. You can protect produce safety by making water-use decisions like treatment before use, or avoiding contact of produce with water, or switching to a different water source that does not have the same vulnerabilities. Treatment does not have to be chemical; some farms use slow sand filters, ultraviolet units, ozone generators, or other methods to remove total coliform bacteria and reduce risk from pathogens. If you want to continue using the well water in contact, without treatment, address conditions that allow intrusion from the surface. Here are some steps you can take:

Considerations for Growing Activities and Hydroponic Systems

Total coliform bacteria usually are not used to indicate risk for water used to grow produce. One exception is for leafy greens, within a 21-days-to-harvest window. The LGMA audit metrics are described in other call-out boxes.

Hydroponic production systems can represent a different concern compared with monitoring source water for intrusion.

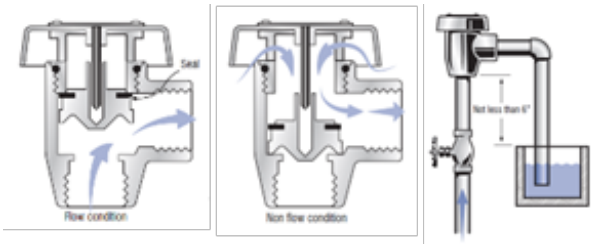
- In many hydroponic systems, it is difficult to completely isolate the harvestable part of growing plants from the nutrient solution and growth media (for example, data by Ilic and others, 2022 show cross-contamination between growth media and harvested produce in an NFT system).
- Conditions that allow total coliforms to grow (water, temperature, nutrients) can also allow human pathogenic bacteria (as well as some plant pathogens) to grow.
- Growth conditions can be particularly favorable in hydroponic nutrient solution, and growth media can concentrate pathogens.

If your hydroponic production operation has high total coliform concentrations in the nutrient growth solution that are difficult to manage, consider making adjustments to reduce the risk that pathogens (if present) will persist and multiply.

- Physical filtration (e.g., high-efficiency membrane filters, slow sand filters), ultraviolet, ozone, and some chemical treatments are options to consider, especially in recirculating-nutrient-type systems.

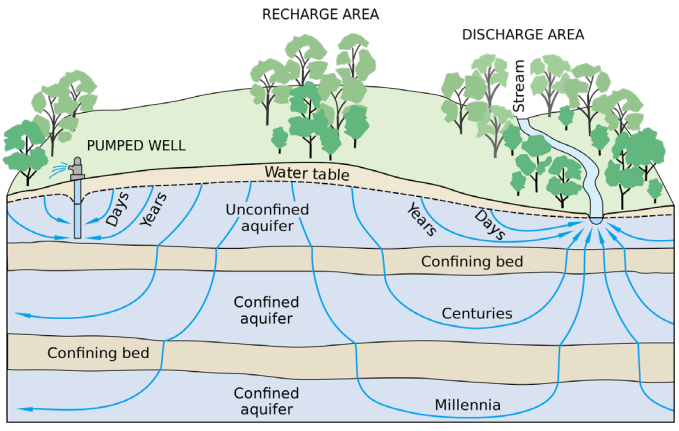
1. **Continue taking water samples to monitor for fecal contamination.** Total coliform-positive water can continue to be used as long as generic *E. coli* is not present. If the total coliform-positive sample was not also tested for generic *E. coli*, you should consider a pause in use until a follow-up test confirms that generic *E. coli* is not detected. It can also be a good idea to sample more than once per year (e.g., weekly, monthly) until the issue is resolved and the water tests negative for total coliforms. Protected well water does not naturally carry total coliforms.

2. **Know where the total coliform-positive water sample came from**. This will help you evaluate potential pathways of intrusion and sources of potential contamination. If the water came straight from the well, you might look at the well structure and possible paths of surface intrusion to the aquifer. If the water came from a faucet or hydrant some distance from the well, also include the on-farm water distribution system in your evaluation. Sampling from multiple locations in the distribution system can help narrow down where intrusion might occur.
3. **Follow the water from the sample location to the source**. Surface issues can be easier to spot and address compared to below-ground issues, so start there. If surface conditions like backflow don't explain system vulnerability to intrusion, consider a down-hole camera or other visual inspection of the well casing, and researching the geology of the aquifer itself. Resources like aquifer maps from USGS (visit this link, or perform a search such as "Principal Aquifers of the United States") or soil surveys from NRCS (websoilsurvey.nrcs.usda.gov/app/) can help you understand natural protections like a clay or solid rock confining layer over the aquifer.



Vacuum breaker from USEPA *Cross-Connection Control Manual* www.epa.gov/sites/default/files/2015-09/documents/epa816r03002_0.pdf

4. **If the conditions that allow intrusion are under your control, take corrective action to protect the water from future intrusion**. Depending on the issue identified, appropriate corrective actions might include installation of a backflow prevention device or replacement of a faulty device, or repairing the structure of the well to restore physical protection from surface intrusion.
5. **If the conditions that allow intrusion are not under your control, find other ways to avoid using potentially-contaminated water on your produce**. Your evaluation of possible intrusion pathways may show that you cannot protect the quality of the water source. For example, the subsurface geology might be sand and gravel with no confining layer to stop surface water from intruding into the aquifer. If so, the aquifer is naturally vulnerable to intrusion. Water quality might be affected by how your neighbors use their land (e.g., wildlife habitat, grazing lands, manure storage).
   Appropriate corrective actions under these conditions might be to change to a less vulnerable water source or change how the water is used (e.g., treat the water before use, avoid contact with produce).



Aquifer entry in Wikipedia en.wikipedia.org/wiki/Aquifer

6. **Re-test to confirm the corrective action(s) was (were) effective**. Testing is one way to confirm the success of your corrective action to protect well water quality. Ground water that is no

longer vulnerable to intrusion from the surface should consistently test negative for total coliform bacteria.

7. **If needed, disinfect the well and distribution system**. Sometimes well water still tests positive for total coliforms even after corrective actions stop the pathway of intrusion. Total coliforms might be protected in biofilms or otherwise resident in the well casing or water distribution system. Consider shocking the well with chlorine, and cleaning the distribution system to remove persistent total coliform bacteria after pathways for potential intrusion have been addressed. Guidance on well disinfection is available from the National Ground Water Association (visit this link, or search for the title "Residential Water Well Disinfection Following a Flood Event"): your state Extension or Department of Public Health, or a local well service contractor, may also have information about shocking a well.
   Always wait several days and purge before re-testing a well after shocking.

Development of this material was supported by the North Central Region FSMA Center, under a grant from the US Department of Agriculture. USDA and other organizations provided technical assistance in developing this material; however, this information has not been formally approved by USDA or any other organization. It does not represent any agency determination or policy.

Prepared by: Don Stoeckel, Environmental consulting.

Reviewed by: Annalisa Hultberg, University of Minnesota; Katelynn Stull, Cal Jamerson, and Manreet Bhullar, Kansas State University; Patrick Byers, University of Missouri; and Londa Nwadike, Kansas State University and University of Missouri.

Elizabeth Bihn, Cornell University, provided additional suggestions for improvement.

This work is supported by the Food Safety Outreach Program [grant no. 2021-70020-35732] from the USDA National Institute of Food and Agriculture.

These institutions are equal opportunity providers. For the full non-discrimination statement or accommodation inquiries, go to www.extension.iastate.edu/diversity/ext.

Updated December 2023