Agricultural Water for Production Overview

Agricultural water used to grow fresh produce can carry and distribute human pathogens. Surface water is more likely to be contaminated by human and animal fecal material than ground water because it is open to the environment. Therefore, it poses a much greater risk to human health when surface water used for irrigation or protective sprays directly contacts the edible portion of the crop. Surface water available for fresh fruit and vegetable production has been found to be contaminated with human pathogens such as *Salmonella, Escherichia coli* 0157:H7, *Giardia, and Cryptosporidium*. Water distribution systems are also of concern, because these systems distribute water throughout the farm and can become contaminated if pipes, backflow devices, or other pieces of the distribution system are not in good condition and functioning properly.

Actions can be taken on the farm to reduce the risks of contamination from agricultural water used during the production of fresh produce.

1. Map and inspect all water sources and distribution systems.
2. Select water application methods that reduce risks by reducing direct contact with the edible portion of the crop.
3. Test all agricultural water for quantified generic *E. coli*.
    a. Identify a water testing laboratory
    b. Sample collection
    c. Delivering samples to the laboratory
4. Keep records of all water management actions and test results.

Map and Inspect All Water Sources and Distribution Systems

Create a map of all water sources and distribution systems to identify how water moves throughout the farm. All water sources, such as surface water and wells, should be inspected at the beginning of the growing season and periodically throughout the season. Surface water sources, such as ponds, lakes, rivers, reservoirs, and canals, should be assessed to determine if wildlife or adjacent land uses pose any contamination risk. Well casings should be inspected to make sure they are intact and well recharge areas should be inspected to make sure no risks are present. Any identified risks should minimized before the water is used for fresh produce production (e.g., repairing broken equipment, treating the water, or using filtration to assure water is sufficiently clean for its intended use).

All distribution systems, as well as equipment used to move water, should be inspected at the beginning of and throughout the growing season to ensure the lines are clear and not likely to introduce microbial risks to the crop receiving the water. This includes repairing broken lines and emitters as well as removing any debris in the lines, such as nesting wildlife, which could lead to contamination. Repairing damaged equipment is very important because broken water emitters can turn a drip system into an overhead system, thereby bringing water in direct contact with the edible portion of the crop. If bacterial pathogens are present in the irrigation water and the water sits stagnant in the pipe between irrigation applications in warm weather, pathogens can multiply in the pipe and potentially incorporated into a biofilm. Water should be drained from the pipe between irrigation applications.

Select Water Application Methods that Reduce Risks

Drip irrigation is the least risky method of water distribution because the water normally does not contact the edible portion of the crop, unless you are growing root vegetables or the drip fine develops a leak. Overhead irrigation and the application of topical crop sprays result in direct water contact with

the edible portion of most crops, so safety is influenced by the quality of water that is applied. If you are using a surface water source for overhead irrigation or for mixing sprays, you should test this water before using it and throughout the production season.

If you have concerns about the quality of your water that comes in direct contact with the crop, there are other actions that can be taken to reduce microbial risks. Test your water so you understand the quality, but you can also:

1. Apply any water that contacts the edible portion of the crop before harvest to allow drying and treatment by UV from sunlight to reduce potential pathogens on the crop.
2. Use water application methods that do not result in direct contact with the edible portion of the crop, such as drip or trickle irrigation. The longer the interval between application of water and harvest, the more risk reduction is possible.

Test all Agricultural Water for Quantified Generic *E. coli*

Water that directly contacts the edible portion of the plant is most important to food safety because water can carry pathogens and contaminate the crop. The source of any water that directly contacts the edible portion of the crop must be tested for quantified generic *E. coli*. This means the test will indicate the number of *E. coli* in the sample, not just if *E. coli* is present or absent. Testing for generic *E*. *coli* is not the same as testing for total coliforms, so be sure to ask specifically for a quantified generic *E. coli* test. The Food Safety Modernization Act (FSMA) proposed produce safety rule specifies if the source is surface water, such as a river, lake, pond, or stream, it must be tested once every week throughout its use if it contacts the harvestable (edible) portion of the crop. If the source is a well, it must be tested at the beginning of the growing season and every three months during the growing season. If the source is a municipal water source, a copy of the municipality's tests or certification of the quality is acceptable as verification of water quality. These are proposed water testing schedules, but they provide an idea of what may be appropriate or required in the future.

The proposed produce safety rule's water standards state that any agricultural water that directly contacts the edible portion of the crop must have less than 235 colony forming units (CFU) or most probable number (MPN) or generic *E. coli* per 100 milliliters (mls) of water sampled for any single sample. The five most recent water samples must have a rolling geometric mean of less than 126 CFU or MPN *E. coil* per 100 mls of water sampled. These standards are derived from EPA recreational water quality standards and have been adapted for the produce industry by the *California Leafy Greens Marketing Agreement* as well as in the FSMA proposed produce safety rule. The FDA is scheduled to release a revision of the water section of the FSMA proposed produce safety rule so these requirements may change. The final rule will not be released until fall of 2015. By starting to test and understand your water source now, you will be better prepared to respond to the final FSMA produce rule.

One way to compare your water tests to these standards is to look at the quantified *E. coil* number on your test results. Is it higher than 235 CFU (or MPN) per 100 mls? If so, you should discontinue use of the water immediately. If the sample is below 235 CFU (or MPN) per 100 mls, then you will need to calculate the rolling geometric mean (n=5) using the last 5 test results you have.

The easiest way to calculate this is to put the numbers into a Microsoft Excel spreadsheet (one number per cell), then click on the Formulas tab and select the GEOMEAN calculation under the Statistical Formulas. Alternatively, you can calculate the geometric mean by multiplying all the numbers together, then take the 5th root of this number. This will give you the rolling geometric mean in CFU (or MPN) per 100 mls. If the rolling geometric mean is less than 126 CFU (or MPN) per 100 mls, you can use the water.

If not, you should not use this water in any way that directly contacts the edible portion of the crop unless it is treated (e.g., filtration, UV, chemically) and confirmed through re-testing to meet these standards. Chemically treating water has its own risks so all treatment options should be evaluated for their effectiveness and appropriateness for the farm and the crops grown.

The only way to know the water quality is to test the water. We recommended testing all agricultural water, but if the water is delivered through drip, it does not have to meet the same standards as water that directly contacts the edible portion of the crop. Some buyers and audit companies have established water standards even for water that does not directly contact the edible portion of the crop. Understanding water quality allows growers to make informed water management decisions, especially once a normal baseline has been established from season to season.

Identify a Water Testing Laboratory

Find a laboratory that is capable of providing the analysis you need. Currently, testing for quantified generic *E. coli* is the industry standard and included in the proposed FSMA produce safety rule. Tests that can achieve this type of analysis with quantified measurement to 235 *E. coli*/l00 ml include Colilert Quantitray 2000 and modified TEC (EPA method 1603). There may be other types of tests that can be used, but be certain to specify the type of water source since many labs are not prepared to handle surface water sources.

Sample Collection and Delivery

Follow the sampling and delivery guidelines required by the laboratory doing the water analysis. This includes using designated sampling containers, sampling methods, and delivery times. Please review the *sample SOP* in this portfolio for bask sampling instructions.

Keep Records of All Water Management Actions and Test Results

Records should be kept for all water tests as well as any water management actions that are taken to identify and reduce risks that may be present in the water or the water delivery system. Template logs are provided to assist you with this recordkeeping process.