



C A L I F O R N I A

**LGMA**

COMMITTED TO SAFE LEAFY GREENS

**COMMODITY SPECIFIC  
FOOD SAFETY GUIDELINES**  
FOR THE PRODUCTION AND HARVEST OF  
LETTUCE AND LEAFY GREENS



**APRIL 19, 2019**

This document supersedes all previously published versions of the Commodity Specific Food Safety Guidelines for the Production and Harvest of Leafy Greens including those dated March 23, 2007, April 18, 2007, June 5, 2007, October 16, 2007, June 13, 2008, July 10, 2009, January 29, 2010, August 4, 2010, July 22, 2011, January 20, 2012, August 31, 2012, August 2, 2013, January 29, 2016, August 10, 2017, and September 28, 2018.

Adopted by the California Leafy Green Products Handler Marketing Agreement Advisory Board  
Document managed by Western Growers - learn more at [www.leafygreenguidance.com](http://www.leafygreenguidance.com)





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## GLOSSARY

**Disclaimer:** Please note the definitions presented here are simplified, functional definitions that have been derived from various resources for specific use in this document and may differ from definitions used in relevant federal, state, and local regulations.

Word	Definition
<b>ACCREDITATION</b>	A rigorous assessment conducted by an independent science-based organization to assure the overall capability and competency of a laboratory and its quality management systems.
<b>ACTIVE COMPOST</b>	Compost feedstock that is in the process of being rapidly decomposed and is unstable. Active compost is generating temperatures of at least 50 degrees Celsius (122 degrees Fahrenheit) during decomposition; or is releasing carbon dioxide at a rate of at least 15 milligrams per gram of compost per day, or the equivalent of oxygen uptake.
<b>ADEQUATE / ADEQUATELY</b>	That which is needed to accomplish the intended purpose in keeping with good public health practice.
<b>AERIAL APPLICATION</b>	Any application administered from above leafy greens where water may come in contact with the edible portion of the crop; may be delivered via aircraft, sprayer, sprinkler, etc.
<b>AEROSOLIZED</b>	The dispersion or discharge of a substance under pressure that generates a suspension of fine particles in air or other gas.
<b>AGRICULTURAL / COMPOST TEA</b>	A water extract of biological materials (such as compost, manure, non-fecal animal byproducts, peat moss, pre-consumer vegetative waste, table waste, or yard trimmings), excluding any form of human waste, produced to transfer microbial biomass, fine particulate organic matter, and soluble chemical components into an aqueous phase. Agricultural / Compost teas are held for longer than one hour before application and are considered non-synthetic crop treatments for the purposes of this document.
<b>AGRICULTURAL TAILWATER</b>	Excess run off water which is generated and collected during the process of irrigation.
<b>ANCILLARY EQUIPMENT</b>	Temporary storage equipment for fertilizers such as third-party storage tanks, pony tanks, etc.
<b>AGRICULTURAL WATER</b>	Water used in activities covered in these guidelines where water is intended to, or is likely to, contact lettuce/leafy greens or food contact surfaces, including water used in growing activities (including all irrigation water and water used for preparing crop sprays) and in harvesting, packing, and holding activities (including water used for washing or cooling harvested lettuce/leafy greens and water used for preventing dehydration of lettuce/leafy greens).



<b>AGRICULTURAL WATER SYSTEM</b>	Each distinct, separate combination of water source, conveyance, storage used to carry water from its primary source to its point of use; includes wells, irrigation canals, pumps, valves, storage tanks, reservoirs, meters, pipes, fittings, and sprinklers.
<b>ANIMAL BY-PRODUCT</b>	Most parts of an animal that do not include muscle meat including organ meat, nervous tissue, cartilage, bone, blood and excrement.
<b>ANIMAL HAZARD</b>	Feeding, skin, feathers, fecal matter or signs of animal presence in an area to be harvested in sufficient number and quantity to suggest to a reasonable person the crop may be contaminated.
<b>ANTIMICROBIAL WATER TREATMENT</b>	A physical, energetic, or chemical agent, applied alone, in combination, or as a sequential process, to achieve and maintain a defined microbiological water quality standard.
<b>ADENOSINE TRI-PHOSPHATE (ATP)</b>	A high-energy phosphate molecule required to provide energy for cellular function.
<b>APPLICATION INTERVAL</b>	Means the time between application of an agricultural input (such as a soil amendment) to a growing area and harvest of leafy greens from the growing area where the agricultural input was applied.
<b>ATP TEST METHODS</b>	Exploits knowledge of the concentration of ATP as related to viable biomass or metabolic activity; provides an estimate of cleanliness.
<b>BIOFERTILIZERS</b>	Fertilizer materials/products that contain microorganisms such as bacteria, fungi, and cyanobacteria that shall promote soil biological activities.
<b>BIOSOLIDS</b>	Solid, semisolid, or liquid residues generated during primary, secondary, or advanced treatment of domestic sanitary sewage through one or more controlled processes.
<b>BLUE VALVE</b>	Pipes which are used as a closed conveyance system for moving agricultural surface water from water source to irrigation systems or reservoirs for agricultural use.
<b>BUILDINGS</b>	Any fully- or partially-enclosed building on the farm that is used for storing of food contact surfaces and packaging materials, including minimal structures that have a roof but no walls.
<b>CLOSED DELIVERY SYSTEM</b>	A water storage or conveyance system which is fully enclosed and protected such that water is not exposed to the environment from the water source to the point of use.
<b>COLONY FORMING UNITS (CFU)</b>	Viable microorganisms (bacteria, yeasts & mold) either consisting of single cells or groups of cells, capable of growth under the prescribed conditions (medium, atmosphere, time and temperature) to develop into visible colonies (colony forming units) which are counted.
<b>CONCENTRATED ANIMAL FEEDING OPERATION (CAFO)</b>	A lot or facility where animals have been, are or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period and crops, vegetation forage growth, or post-harvest residues are not sustained in the normal



	growing season over any portion of the lot or facility. In addition, there must be more than 1,000 'animal units' (as defined in 40 CFR 122.23) confined at the facility; or more than 300 animal units confined at the facility if either one of the following conditions are met: pollutants are discharged into navigable waters through a man-made ditch, flushing system or other similar man-made device; or pollutants are discharged directly into waters of the United States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation.
<b>COLIFORMS</b>	Gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose to gas. They are frequently used as indicators of process control but exist broadly in nature.
<b>CO-MANAGEMENT</b>	An approach to conserving soil, water, air, wildlife, and other natural resources while simultaneously minimizing microbiological hazards associated with food production.
<b>COMPOSTING</b>	Means a process to produce compost in which organic material is decomposed by the actions of microorganisms under thermophilic conditions for a designated time period (for example, 3 days) at a designated temperature (for example, 131 °F (55 °C)), followed by a curing stage under cooler conditions.
<b>CROSS-CONTAMINATION</b>	The transfer of microorganisms, such as bacteria and viruses, from one place to another.
<b>CURING</b>	The final stage of composting, which is conducted after much of the readily metabolized biological material has been decomposed, at cooler temperatures than those in the thermophilic phase of composting, to further reduce pathogens, promote further decomposition of cellulose and lignin, and stabilize composition. Curing may or may not involve insulation, depending on environmental conditions.
<b>DETECTION LIMIT</b>	A detection limit is the lowest quantity of a substance or measurable target that can be distinguished from the absence of that substance or measurable target. Methods that estimate bacterial populations in serial dilutions are limited to a minimum level of <2.2 MPN/100 mL and methods that count bacterial colonies growing on media are limited to a minimum level of <1.0 CFU/100 mL.
<b>DIRECT WATER APPLICATION</b>	Using agricultural water in a manner whereby the water is intended to, or is likely to, contact leafy greens or food contact surfaces during use of the water.
<b>ENTEROHEMORRHAGIC <i>E. COLI</i></b>	Shiga toxin-producing <i>E. coli</i> clinically associated with bloody diarrhea.
<b><i>ESCHERICHIA COLI</i> (<i>E. COLI</i>)</b>	<i>Escherichia coli</i> are common bacteria that live in the lower intestines of animals (including humans) and are generally not harmful. <i>E. coli</i> are frequently used as an indicator of fecal contamination but can be found in nature from non-fecal sources.
<b>FECAL COLIFORMS</b>	Coliform bacteria that grow at elevated temperatures and may or may not be of fecal origin. Useful to monitor effectiveness of composting processes. Also called "thermotolerant coliforms."



<b>FIELD EQUIPMENT</b>	Equipment used to: prepare the production area and plant, cultivate, fertilize, treat or any other pre-harvest in-field activities.
<b>FLOODING</b>	The flowing or overflowing of a field with water outside a grower’s control that is reasonably likely to contain microorganisms of significant public health concern and is reasonably likely to cause adulteration of edible portions of fresh produce in that field.
<b>FOOD-CONTACT SURFACE</b>	Those surfaces that contact human food and those surfaces from which drainage, or other transfer, onto the food or onto surfaces that contact the food ordinarily occurs during the normal course of operations. “Food contact surfaces” includes food contact surfaces of equipment and tools used during harvest, packing and holding.
<b>FOOD SAFETY ASSESSMENT</b>	A standardized procedure that predicts the likelihood of harm resulting from exposure to chemical, microbial and physical agents in the diet.
<b>FOOD SAFETY PERSONNEL</b>	Person trained in basic food safety principals and/or working under the auspices of a food safety professional.
<b>FOOD SAFETY PROFESSIONAL</b>	Person entrusted with management level responsibility for conducting food safety assessments before food reaches consumers; requires documented training in scientific principles and a solid understanding of the principles of food safety as applied to agricultural production; in addition this individual must have successfully completed food safety training at least equivalent to that received under standardized curriculum recognized as adequate by the Food and Drug Administration See appendix B for more details.
<b>GEOMETRIC MEAN</b>	Mathematical def.: the $n^{\text{th}}$ root of the product of $n$ numbers, or: Geometric Mean = $n^{\text{th}}$ root of $(X_1)(X_2)...(X_n)$ , where $X_1, X_2,$ etc. represent the individual data points, and $n$ is the total number of data points used in the calculation. Practical def.: the average of the logarithmic values of a data set, converted back to a base 10 number.
<b>GREEN WASTE</b>	Any plant material that is separated at the point of generation contains no greater than 1.0 percent of physical contaminants by weight. Green material includes, but is not limited to, yard trimmings ("Yard Trimmings" means any wastes generated from the maintenance or alteration of public, commercial or residential landscapes including, but not limited to, yard clippings, leaves, tree trimmings, prunings, brush, and weeds), untreated wood wastes, natural fiber products, and construction and demolition wood waste. Green material does not include food material, biosolids, mixed solid waste, material processed from commingled collection, wood containing lead-based paint or wood preservative, mixed construction or mixed demolition debris. "Separated At The Point of Generation" includes material separated from the solid waste stream by the generator of that material. It may also include material from a centralized facility as long as that material was kept separate from the waste stream prior to receipt by that facility and the material was not commingled with other materials during handling. <sup>1</sup>



<b>GROUND WATER</b>	The supply of fresh water found beneath the earth’s surface, usually in aquifers, which supply wells and springs. Ground water does not include any water that meets the definition of surface water.
<b>HARVESTING</b>	Activities that are traditionally performed on farms for the purpose of removing leafy greens from the field and preparing them for use as food; does not include activities that transform a raw agricultural commodity into a processed food. Examples of harvesting include cutting (or otherwise separating) the edible portion of the leafy greens from the crop plant and removing or trimming parts, cooling, field coring, gathering, hulling, removing stems, trimming of outer leaves of, and washing.
<b>HARVEST EQUIPMENT</b>	Any kind of equipment which is used during or to assist with the harvesting process including but not limited to harvesting machines, food contact tables, belts, knives, etc.
<b>HAZARD</b>	Any biological, physical, or chemical agent that has the potential to cause illness or injury in the absence of its control.
<b>HOLDING</b>	Storage of leafy greens in warehouses, cold storage, etc. including activities performed incidental to storage ( <i>e.g.</i> , activities performed for safe or effective leafy green storage) as well as activities performed as a practical necessity for leafy green distribution (such as blending and breaking down pallets) but does not include activities that transform the raw commodity into a processed food.
<b>HYDROPONIC</b>	The growing of plants in nutrient solutions with or without an inert medium (as soil) to provide mechanical support.
<b>INDICATOR MICROORGANISMS</b>	An organism that when present suggests the possibility of contamination or under processing.
<b>KNOWN OR REASONABLY FORESEEABLE HAZARD</b>	Known or reasonably foreseeable hazard means a biological, chemical, and physical hazard that is known to be, or has the potential to be, associated with the farm or the food.
<b>LEAFY GREENS</b>	Iceberg lettuce, romaine lettuce, green leaf lettuce, red leaf lettuce, butter lettuce, baby leaf lettuce (i.e., immature lettuce or leafy greens), escarole, endive, spring mix, spinach, cabbage (green, red and savoy), kale, arugula and chard.
<b>MANURE</b>	Animal excreta, alone or in combination with litter (such as straw and feathers used for animal bedding) for use as a soil amendment.
<b>MICROORGANISMS</b>	Yeasts, molds, bacteria, viruses, protozoa, and microscopic parasites and includes species having public health significance and those subjecting leafy greens to decomposition or that otherwise may cause leafy greens to be adulterated.
<b>MONITOR</b>	To conduct a planned sequence of observations or measurements to assess whether a process, point or procedure is under control and, when required, to produce an accurate record of the observation or measurement.



<b>MONTHLY</b>	Because irrigation schedules and delivery of water is not always in a grower’s control “monthly” for purposes of water sampling means within 35 days of the previous sample.
<b>MOST PROBABLE NUMBER (MPN)</b>	Estimated values that are statistical in nature; a method for enumeration of microbes in a sample, particularly when present in small numbers.
<b>MUNICIPAL WATER</b>	Water that is processed and treated by a municipality to meet USEPA drinking water standards.
<b>NON-SYNTHETIC CROP TREATMENTS</b>	Any crop input that contains animal manure, an animal product, and/or an animal by-product that is reasonably likely to contain human pathogens. Includes agricultural or compost teas for the purposes of these guidelines.
<b>OPEN DELIVERY SYSTEM</b>	A water storage or conveyance system which is partially or fully open and unprotected such that water is exposed to the environment at any point from the water source to the point of use.
<b>OXIDATION REDUCTION POTENTIAL (ORP)</b>	An intrinsic property that indicates the tendency of a chemical species to acquire electrons and so be reduced; the more positive the ORP, the greater the species’ affinity for electrons.
<b>PACKING</b>	Placing leafy greens into a container other than packaging them and also includes activities performed incidental to packing ( <i>e.g.</i> , activities performed for the safe or effective packing of leafy greens (such as sorting, culling, grading, and weighing or conveying incidental to packing or repacking)).
<b>PARTS PER MILLION (PPM)</b>	Usually describes the concentration of something in water or soil; one particle of a given substance for every 999,999 other particles.
<b>PATHOGEN</b>	A disease-causing agent such as a virus, parasite, or bacteria.
<b>PEST</b>	Any objectionable animals or insects, including birds, rodents, flies, and larvae.
<b>POOLED WATER</b>	An accumulation of standing water; not free-flowing.
<b>POTABLE WATER</b>	Water that is safe to drink or to use for food preparation without risk of health problems.
<b>PROCESS AUTHORITY</b>	A regulatory body, person, or organization that has specific responsibility and knowledge regarding a particular process or method; these authorities publish standards, metrics, or guidance for these processes and/or methods.
<b>READY-TO-EAT (RTE) FOOD (EXCERPTED FROM USFDA 2005 MODEL FOOD CODE)</b>	(1) "Ready-to-eat food" means FOOD that: (a) Is in a form that is edible without additional preparation to achieve FOOD safety, as specified under one of the following: 3-401.11(A) or (B), § 3-401.12, or § 3-402.11, or as specified in 3-401.11(C); or (d) May receive additional preparation for palatability or aesthetic, epicurean, gastronomic, or culinary purposes. (2) "Ready-to-eat food" includes: (b) Raw fruits and vegetables that are washed as specified under § 3-302.15;



	<p>(c) Fruits and vegetables that are cooked for hot holding, as specified under § 3-401.13;</p> <p>(e) Plant FOOD for which further washing, cooking, or other processing is not required for FOOD safety, and from which rinds, peels, husks, or shells, if naturally present are removed.</p>
<b>RISK MITIGATION</b>	Actions to reduce the severity/impact of a risk.
<b>SANITARY FACILITY</b>	Includes both toilet and hand-washing stations.
<b>SANITIZE</b>	To adequately treat cleaned surfaces by a process that is effective in destroying vegetative cells of microorganisms of public health significance, and in substantially reducing numbers of other undesirable microorganisms, but without adversely affecting the product or its safety for the consumer.
<b>SHIGA-TOXIN PRODUCING E. COLI</b>	Bacteria found in the environment, foods, and animal and human intestines that produce a potent disease-causing toxin. The serogroup most commonly identified and associated with severe illness and hospitalization in the United States is <i>E. coli</i> O157; however, there are over 50 other serogroups that can also cause illness.
<b>SHIPPING UNIT/ EQUIPMENT</b>	Any cargo area used to transport leafy greens on the farm or from the farm to cooling, packing, or processing facilities.
<b>SOIL AMENDMENT</b>	Elements added to the soil, such as compost, peat moss, or fertilizer, to improve its capacity to support plant life.
<b>SURFACE WATER</b>	Water either stored or conveyed on the surface and open to the environment. (e.g. rivers, lakes, streams, reservoirs, etc.)
<b>SYNTHETIC CROP TREATMENTS (CHEMICAL FERTILIZERS)</b>	Any crop inputs that may be refined, and/or chemically synthesized and/or transformed through a chemical process (e.g. gypsum, lime, sulfur, potash, ammonium sulfate etc.).
<b>TRANSPORTER</b>	The entity responsible for transporting product from the field; LGMA guidelines apply only to handlers and cover production through harvesting.
<b>ULTRAVIOLET INDEX (UV INDEX)</b>	A measure of the solar ultraviolet intensity at the Earth's surface; indicates the day's exposure to ultraviolet rays. The UV index is measured around noon for a one-hour period and rated on a scale of 0-15.
<b>VALIDATED PROCESS</b>	A process that has been demonstrated to be effective through a statistically based study, literature, or regulatory guidance.
<b>VALIDATION</b>	The act of determining whether products or services conform to meet specific requirements.
<b>VERIFICATION</b>	The act of confirming a product or service meets the requirements for which it was intended.



<b>VISITOR</b>	Any person (other than personnel) who enters your field/operations with your permission.
<b>WATER DISTRIBUTION SYSTEM</b>	Distribution systems -- consisting of pipes, pumps, valves, storage tanks, reservoirs, meters, fittings, and other hydraulic appurtenances - to carry water from its primary source to a lettuce and leafy green crop.
<b>WATER SOURCE</b>	The location from which water originates; water sources can be municipal, well or surface water such as rivers, lakes or streams.
<b>WATER TREATMENT</b>	Any process that improves the quality (safety) of the water to make it more acceptable for a specific end-use.
<b>WATER USE</b>	The method by which water is being used in the agricultural process.
<b>WELL</b>	An artificial excavation put down by any method for the purposes of withdrawing water from the underground aquifers. A bored, drilled, or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies



## ACRONYMS AND ABBREVIATIONS

<b>AOAC</b>	AOAC International (formerly the Association of Official Analytical Chemists)
<b>BAM</b>	Bacteriological Analytical Manual
<b>CAFOs</b>	Concentrated animal feeding operations
<b>CSG2</b>	<i>Commodity Specific Guidance for Leafy Greens and Lettuce, 2<sup>nd</sup> Edition</i>
<b>CFU</b>	Colony Forming Units
<b>cGMP</b>	Current Good Manufacturing Practices
<b>COA</b>	Certificate of Analysis
<b>DL</b>	Detection Limit
<b>FDA</b>	Food and Drug Administration
<b>FSMA</b>	Food Safety Modernization Act
<b>GAPs</b>	Good Agricultural Practices
<b>GLPs</b>	Good laboratory practices
<b>HACCP</b>	Hazard Analysis Critical Control Point
<b>mL</b>	Milliliter
<b>MPN</b>	Most Probable Number
<b>NRCS</b>	Natural Resources Conservation Service
<b>ORP</b>	Oxidation Reduction Potential
<b>PPM</b>	Parts per million
<b>SOP</b>	Standard Operating Procedure
<b>SSOPs</b>	Sanitation Standard Operating Procedures
<b>STEC</b>	Shiga-toxin producing <i>E. coli</i>
<b>USDA</b>	United States Department of Agriculture
<b>US EPA</b>	United States Environmental Protection Agency
<b>UV</b>	Ultraviolet
<b>WHO</b>	World Health Organization



## LIST OF APPENDICES

[Appendix A](#): Agricultural Water System Assessment

[Appendix B](#): Technical Basis Document

[Appendix C](#): Crop Sampling Protocol

[Appendix D](#): Kinetics of Microbial Inactivation for Alternative Food Processing Technologies

[Appendix E](#): Environmental Health Standards for Composting Operations (California Code of Regulations)

[Appendix X](#): Guidance for Soil Collection for Cadmium Analysis

[Appendix Y](#): Guidance for Developing Best Management Practices to Reduce Cadmium Uptake by Spinach

[Appendix Z](#): CA Resource Agency Contacts



## INTRODUCTION

In 1998, the U.S. Food and Drug Administration (FDA) issued its “Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables”. The practices outlined in the FDA’s guidance and other industry documents are collectively known as Good Agricultural Practices or GAPs. GAPs provide general food safety guidance on critical production steps where food safety might be compromised during the growing, harvesting, transportation, cooling, packing and storage of fresh produce. More specifically, GAP guidance alerts fruit and vegetable growers, shippers, packers and processors to the potential microbiological hazards associated with various aspects of the production chain including: land history, adjacent land use, water quality, worker hygiene, pesticide and fertilizer use, equipment sanitation and product transportation.

In 2011, the Food Safety Modernization Act (FSMA) was signed into law. After several years of gathering stakeholder input, the FDA published the final regulations promulgating FSMA requirements including regulation of farming operations for the first time in U.S. history. The *Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption* (the Produce Safety Rule) is the rule that addresses GAPs for farming operations.

The vast majority of the lettuce/leafy greens industry have adopted GAPs as part of normal production operations. Indeed, the majority of lettuce/leafy greens producers undergo either internal or external third-party GAP audits on a regular basis to monitor and verify adherence to their GAPs programs. These audit results are often shared with customers as verification of the producer’s commitment to food safety and GAPs.

While the produce industry has an admirable record of providing the general public with safe, nutritious fruits and vegetables, it remains committed to continuous improvement with regard to food safety. In 2004, the FDA published a food safety action plan that specifically requested produce industry leadership in developing the next generation of food safety guidance for fruit and vegetable production. These new commodity-specific guidelines focus on providing guidance that enhances the safe growing, processing, distribution and handling of commodities from the field to the end user. The 1<sup>st</sup> Edition of these new voluntary guidelines was published by the industry in April 2006.

In response to the continued concerns regarding the microbial safety of fresh produce, these guidelines were prepared to provide more specific and quantitative measures of identified best practices for leafy greens production and harvest. In meeting their commitment to keeping the guidelines up-to-date with new scientific and technical advancements, the leafy greens industry has treated the food safety guidelines as a dynamic document by providing routine opportunities for industry members and other stakeholders to recommend revisions and additions. In addition, the guidelines have been updated to reflect the Produce Safety Rule requirements and peer-reviewed research funded by the Center for Produce Safety.

A key focus of revisions is to identify, where possible and practical, metrics and measures that can be used to assist the industry in complying with these industry guidelines.

In preparing the original document, metrics were researched for three primary areas: water quality, soil amendments, and environmental assessments/conditions. A three-tier approach was used to identify these metrics in as rigorous a manner as possible:

1. A comprehensive literature review was conducted to determine if there was a scientifically valid basis for establishing a metric for the identified risk factor or best practice.
2. If the literature research did not identify scientific studies that could support an appropriate metric, standards or metrics from authoritative or regulatory bodies were used to establish a metric.



3. If neither scientific studies nor authoritative bodies had allowed for suitable metrics, consensus among industry representatives and/or other stakeholders was sought to establish metrics.

In the last 10 years, the focus of food safety efforts has been on the farm, initial cooling and distribution points, and value-added processing operations. Fruit and vegetable processing operations have developed sophisticated food safety programs largely centered on current Good Manufacturing Practices (cGMPs) and the principles of Hazard Analysis Critical Control Point (HACCP) programs. As we develop a greater understanding of food safety issues relative to the full spectrum of supply and distribution channels for fruits and vegetables, it has become clear that the next generation of food safety guidance needs to encompass the entire supply chain.

In addition to this document, several supplemental documents have been prepared to explain the rationale for the metrics and assist the grower with activities in the field. These documents include a *Technical Basis Document* that describes in detail and with appropriate citations, the bases for the changes made in this edition of this document, an *Agricultural Water System Assessment* document that describes the processes for assessing the integrity and remediation of agricultural water systems, and an example product testing plan. All of these items can be found as Appendices to this document.

## SCOPE

The scope of this document pertains only to fresh and fresh-cut lettuce and leafy greens products. It does not include products commingled with non-produce ingredients (e.g. salad kits that may contain meat, cheese, and/or dressings). Examples of “lettuce/leafy greens” include iceberg lettuce, romaine lettuce, green leaf lettuce, red leaf lettuce, butter lettuce, baby leaf lettuce (i.e., immature lettuce or leafy greens), escarole, endive, spring mix, cabbage (green, red and savoy), kale, arugula and chard and spinach. These crops are typically considered lettuce and leafy greens by the FDA but may not be similarly defined by other state or federal regulatory bodies. This document is also limited to offering food safety best practices consistent with the Produce Safety Rule’s provisions for crops grown under outdoor field growing practices and may not address food safety issues related to hydroponic and/or soil-less media production techniques for lettuce/leafy greens.

Lettuce/leafy greens may be harvested mechanically or by hand and are almost always consumed uncooked or raw. Because lettuce/leafy greens may be hand-harvested and hand-sorted for quality, there are numerous “touch points” early in the supply chain and a similar number of “touch points” later in the supply chain as the products are used in foodservice or retail operations. Each of these “touch points” represents a potential opportunity for cross-contamination. For purposes of this document, a “touch point” is any occasion when the food is handled by a worker or contacts an equipment food-contact surface.

Lettuce/leafy greens present multiple opportunities to employ food safety risk management practices to enhance the safety of lettuce/leafy greens. In the production and harvest of lettuce and leafy greens as raw agricultural commodities, GAPs are commonly employed in order to produce the safest products possible. In a processing operation, the basic principles of cGMPs, HACCP, sanitation, and documented operating procedures are commonly employed in order to produce the safest products possible. Lettuce/leafy greens are highly perishable, and it is strongly recommended that they be distributed, stored, and displayed under refrigeration.

Safe production, packing, processing, distribution and handling of lettuce/leafy greens depend upon a myriad of factors and the diligent efforts and food safety commitment of many parties throughout the distribution chain. No single resource document can anticipate every food safety issue or provide answers to all food safety questions. These guidelines focus primarily on minimizing the microbial food safety hazards by providing suggested actions to



reduce, control or eliminate microbial contamination of lettuce/leafy greens in the field to fork distribution supply chain.

All companies involved in the lettuce/leafy greens farm-to-table supply chain should implement the recommendations contained within these guidelines to provide for the safe production and handling of lettuce/leafy greens products from field-to-fork. Every effort to provide food safety education to supply chain partners should also be made. Together with the commitment of each party along the supply chain to review and implement these guidelines, the fresh produce industry is doing its part to provide a consistent, safe supply of leafy greens to the market.

These guidelines are intended only to convey the best practices associated with the industry. The Produce Marketing Association, the United Fresh Produce Association, Western Growers, and all other contributors and reviewers make no claims or warranties about any specific actions contained herein. It is the responsibility of any purveyor of food to maintain strict compliance with all local, state and federal laws, rules and regulations. These guidelines are designed to facilitate inquiries and developing information that must be independently evaluated by all parties with regard to compliance with legal and regulatory requirements. The providers of this document do not certify compliance with these guidelines and do not endorse companies or products based upon their use of these guidelines.

Differences between products, production processes, distribution and consumption, and the ever-changing state of knowledge regarding food safety make it impossible for any single document to be comprehensive and absolutely authoritative. Users of these guidelines should be aware that scientific and regulatory authorities are periodically revising information regarding best practices in food handling, as well as information regarding potential food safety management issues. Users of this document must bear in mind that as knowledge regarding food safety changes, measures to address those changes will also change as will the emphasis on particular issues by regulators and the regulations themselves. Neither this document nor the measures food producers and distributors should take to address food safety are set in stone.

Due to the close association between production blocks and environmentally sensitive areas in many locations, it is recommended that Appendix Z be reviewed when any mitigation strategies could potentially impact these areas. Growers should implement strategies that not only protect food safety but also support co-management. All parties involved with implementing the practices outlined in this document should be aware that these metrics are not meant to be in conflict with or discourage co-management practices and principles.

Users are encouraged to utilize the services of their trade associations, the FDA, the Center for Produce Safety, the U.S. Department of Agriculture (USDA), the U.S. Environmental Protection Agency (U.S. EPA), the Centers for Disease Control and Prevention (CDC), and state agricultural, environmental, academic, wildlife and natural resources management agencies and/or public health authorities.

The Agricultural Water System Assessment and Technical Basis Document prepared as Appendices to these guidelines considered to be additional resources. They are intended to provide clarification, assist with interpretation and provide additional guidance as users develop food safety programs based on these guidelines. They are not intended for measurement or verification purposes.



## LETTUCE/LEAFY GREENS COMMODITY SPECIFIC GUIDANCE PRODUCTION & HARVEST UNIT OPERATIONS

### 1. PURPOSE

The issues identified in this document are based on the core elements of Good Agricultural Practices. The specific recommendations contained herein are intended for lettuce and leafy greens only. If these specific recommendations are effectively implemented this would constitute the best practices for a GAP program for the production and harvest unit operations of lettuce and leafy greens.

### 2. GENERAL REQUIREMENTS

In addition to the area-specific requirements discussed in latter sections, there are several general requirements that are part of an effective best practices program. These requirements are outlined below.

#### THE BEST PRACTICES ARE:

- A written Leafy Greens Compliance Plan shall be prepared that specifically addresses the Best Practices listed in this document. This plan shall address at least for the following areas: water, soil amendments, environmental factors, work practices, and field sanitation.
- Handlers shall have an up-to-date growers list with contact and location information on file.
- The handler shall comply with the requirements of The Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (farms are exempt from the Act) including those requirements for recordkeeping (traceability) and registration...
- Designate an individual responsible for their operation's food safety program. Twenty-four-hour contact information shall be available for this individual in case of food safety emergencies.

### 3. RECORDS

The best practices below complement, but do not supersede recordkeeping requirements in FDA regulations.

#### THE BEST PRACTICES ARE:

- All records must include (as applicable to the record):
  - The name (or an identifier e.g., a number that can be linked to the farm/ranch name) and location of the farm
  - Actual values and observations obtained during monitoring
  - An adequate description (e.g., commodity name / specific variety / brand name and any lot number or other identifier) of the leafy green product applicable to the record
  - The location of the growing area (e.g., a specific field) applicable to the record
  - The date and time of the activity documented



- 121 • All records must be:
  - 122 ○ Created at the time an activity is performed or observed
  - 123 ○ Accurate, legible, and indelible
  - 124 ○ Dated and signed / initialed by the person (or a member of the crew / team) performing the activity
  - 125 ○ documented (does not include the supervisor of those performing the activity)
- 126 • All records and documents of policies, procedures, and activities to fulfill requirements related to the Leafy
- 127 Greens Compliance Plan shall be maintained on-site, at an off-site location, or accessible electronically and
- 128 shall be available for inspection by the end of the day the audit is conducted.
- 129 • Existing records (e.g., records that are kept in compliance with other federal, state, or local regulations or
- 130 for any other reason) do not need to be duplicated if they contain all of the required information and satisfy
- 131 the requirements herein. Existing records may be supplemented as necessary to include all of the required
- 132 information and satisfy the requirements of this section. Records must be kept in the original, electronically
- 133 or as true copies (e.g., photocopies, pictures, scanned copies, microfilm, microfiche, or other accurate
- 134 reproductions of the original records).
- 135 • All required historical records must be readily available and accessible during the retention period for
- 136 inspection and copying by the LGMA auditor upon oral or written request, except that you have 24 hours
- 137 to obtain records you keep offsite and make them available and accessible to the auditors for inspection
- 138 and copying.
- 139 • If you use electronic techniques to keep records, or to keep true copies of records, or if you use reduction
- 140 techniques such as microfilm to keep true copies of records, you must provide the records in a format in
- 141 which they are accessible and legible.
- 142 • Records shall be kept for a minimum of two years following the date of issuance or occurrence.
- 143 • Records that relate to the general adequacy of the equipment or processes or records that relate to
- 144 analyses, sampling, or action plans being used by a farm, including the results of scientific studies, tests,
- 145 and evaluations, must be retained at the farm for at least 2 years after the use of such equipment or
- 146 processes, or records related to analyses, sampling, or action plans, is discontinued.

#### 147 4. PERSONNEL QUALIFICATIONS AND TRAINING

148 Adequate training of on-farm and handler personnel is a critically important element in a successful food safety  
149 program. In order to align with federal requirements under the Food Safety Modernization Act (FSMA) and to  
150 ensure that all activities prescribed in this document are effectively and adequately implemented, the following  
151 minimum training requirements must be maintained and documented:

##### 152 THE BEST PRACTICES ARE:

- 153 • All personnel (including temporary, part time, seasonal, and contracted personnel) who handle lettuce /  
154 leafy greens or who have contact with food-contact surfaces, or who are engaged in the supervision thereof,  
155 must:
  - 156 ○ Receive adequate training, as appropriate to the person's duties, upon hiring, and periodically
  - 157 ○ thereafter, at least once annually.



- 158 ○ Have a combination of education, training, and experience necessary to perform the person's  
159 assigned duties in a manner that ensures compliance with these best practices.
- 160 ● Training must be:
  - 161 ○ Conducted in a manner easily understood by personnel being trained.
  - 162 ○ Repeated as necessary and appropriate based on observations or information indicating that  
163 personnel are not meeting standards outlined in these best practices.
- 164 ● Minimum training requirements must include:
  - 165 ○ For all personnel who handle (contact) lettuce/leafy greens or supervise those who do so must  
166 receive training that includes the following:
    - 167 ■ Principles of food hygiene and safety.
    - 168 ■ The importance of health and personal hygiene for all personnel and visitors including  
169 recognizing symptoms of a health condition that is reasonably likely to result in  
170 contamination of lettuce/leafy greens or food-contact surfaces with microorganisms of  
171 public health significance.
    - 172 ■ The standards established in these best practices that are applicable to the employee's job  
173 responsibilities.
  - 174 ○ For harvest personnel, the training program must also address the following minimum  
175 requirements related to harvesting activities:
    - 176 ■ Recognizing lettuce/leafy greens that must not be harvested, including product that may  
177 be contaminated with known or reasonably foreseeable hazards.
    - 178 ■ Inspecting harvest containers, harvest equipment, and packaging materials to ensure that  
179 they are functioning properly, clean, and maintained so as not to become a source of  
180 contamination of lettuce/leafy greens with known or reasonably foreseeable hazards.
    - 181 ■ Correcting problems with harvest containers, harvest equipment, or packaging materials or  
182 reporting such problems to the supervisor (or other responsible party), as appropriate to  
183 the person's job responsibilities.
- 184 ● At least one supervisor or responsible party (e.g., the food safety professional) for each grower providing  
185 leafy green products must have successfully completed food safety training at least equivalent to that  
186 received under standardized curriculum recognized as adequate by the FDA.
- 187 ● Establish and keep records of training that document required training of personnel, including the date of  
188 training, topics covered, and the person(s) trained. Records must be reviewed, dated, and signed, within a  
189 week after the records are made, by a supervisor or responsible party.

## 190 5. ENVIRONMENTAL ASSESSMENTS

191 This section addresses assessments that shall be completed and documented prior to the first seasonal planting,  
192 within one week prior to harvesting and during harvest operations. These environmental assessments are intended



193 to identify any issues related to the produce field, adjacent land uses, and/or animal hazards that may present a  
194 risk to the production block or crop (see Tables 6 and 7).

195 **THE BEST PRACTICES ARE:**

196 • Prior to the first seasonal planting and within one week prior to harvest, perform and document an  
197 environmental risk assessment of the production field and surrounding area. Focus these assessments on  
198 evaluating the production field for possible animal hazards or other sources of human pathogens of  
199 concern, assessing adjacent land uses for possible sources that might contaminate the production field, and  
200 evaluating nearby water sources for the potential of past or present flooding.

201 ○ **Assessment of Produce Field**

202 Evaluate all produce fields for evidence of animal hazards and/or feces. If any evidence is found,  
203 follow procedures identified in the “Production Locations - Encroachment by Animals and Urban  
204 Settings.”

205 Evaluate potential environmental sources of contaminants near production locations after a  
206 change in weather conditions or weather events that could impact the original risk assessment  
207 of the field or block and follow procedures identified in the “Production Locations - Climatic  
208 Conditions and Environment” section below.

209 ○ **Assessment of Adjacent Land Use**

210 Evaluate all land and waterways adjacent to all production fields for possible sources of human  
211 pathogen of concern. These sources include, but are not limited to manure storage, compost  
212 storage, CAFO’s, grazing/open range areas, surface water, sanitary facilities, and composting  
213 operations (see Table 7 for further detail). If any possible uses that might result in produce  
214 contamination are present, consult with the metrics and refer to Appendix Z.

215 ○ **Assessment of CAFOs**

216 Conduct and document a rigorous pre-season environmental assessment of any Concentrated  
217 Animal Feeding Operation that may impact your operation. Include, to the degree possible,  
218 communication with the CAFO operator and/or third-party operator to document Best  
219 Management Practices (BMPs) within the facility, examination of the CAFO for locations and  
220 risk associated with composting, storage, sick pens, dead piles and other internal operations,  
221 examination of traffic routes associated with the CAFO and examine settling and manure ponds  
222 for any signs of leakage. Note if the CAFO drainage or discharge is a possible source of  
223 contamination. Record the approximate number of animals within the CAFO and the method  
224 used to determine.

225 Conduct and document a pre-harvest assessment that confirms no changes in pre-season  
226 conditions. Note if any discharge events that may impact your crop or operations; changes in  
227 weather condition or weather events occurred during the production period.

228 Water sources that are proximate to a CAFO may pose additional risk and should be closely  
229 evaluated. Refer to Appendix A: Agricultural Water System Assessment.

230 ○ **Assessment of Historical Land Use**



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To the degree practical, determine and document the historical land uses for production fields and any potential issues from these uses that might impact food safety (i.e., hazardous waste sites, landfills, etc.).

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- **Assessment of Flooding**

Evaluate all produce fields for evidence of flooding. If any evidence is found, follow procedures identified in the “Flooding” section below.

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- Prior to the first use of a production block intended for spinach, evaluate the soil for the presence of cadmium. If cadmium is determined to be present, further evaluation and mitigation may be necessary (see Section 17). Cadmium concentration is generally stable and further evaluation is unnecessary over time.

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## 6. ISSUE: WATER

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The safety of whole fresh and fresh-cut (e.g., bagged salad) leafy greens is a longstanding issue. Leafy greens are mostly consumed raw without cooking or processing steps to eliminate microbial hazards. Therefore, the way they are grown, harvested, packed, held, processed, and distributed is crucial to ensuring that the risk of human pathogen contamination is minimized. These metrics are intended to prioritize risk by classifying agricultural water systems for specific uses within leafy greens operations. Remedial actions follow a “find and fix” structure to identify and correct both system nonconformities and more serious failures. These metrics should be considered the minimum controls necessary to assess agricultural water systems for fitness of use.

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### GENERAL AGRICULTURAL WATER MANAGEMENT - THE BEST PRACTICES ARE:

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- Agricultural water systems are a function of the source, storage, and conveyance. Each component of an agricultural water system that is within your control must be evaluated to ensure that the quality of agricultural water used in leafy green operations is known (i.e., the required parameters are measured and conform to the prescribed standards) and adequate for its intended use.

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- It’s prudent to evaluate and make a good faith effort to address the food safety hazards proximate to your agricultural water systems that may not be under your control.

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- NEVER use water from any water system that has not been microbially characterized.

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- A water system description shall be prepared. This description can use maps, photographs, drawings or other means to communicate the location of permanent fixtures and the flow of the water system (including any water captured for re-use or other natural or managed features which prevent environmental runoff from entering the water system).

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- All components of your agricultural water system that are within your control including the water source and the on-ranch (farm) distribution /conveyance system(s) must be managed and maintained in a manner that minimizes human pathogen contamination. Testing water at the end of the delivery system (e.g., the last sprinkler head) or the point-of-use is essential for ensuring water that contacts the crop is of adequate microbial quality.

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- Water systems that convey untreated human or animal waste are never suitable for use in leafy greens operations in any manner and must be separated from conveyances utilized to deliver agricultural water.

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### HAZARD ANALYSIS - STEP 1: ASSESSMENT OF AGRICULTURAL WATER SYSTEMS

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Evaluating food safety hazards from agricultural water applications in leafy green operations must take into account the quality of the agricultural water system, how the agricultural water will be applied, and when it will be applied. Prior to using water in any leafy green operation, conduct an agricultural water system assessment (including source, storage, and conveyance as described in Appendix A) and determine the agricultural water system type.

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- 1) **System:** Each component of an agricultural water system must be evaluated to ensure that the quality of agricultural water used in leafy green operations is known (i.e., the required parameters are measured and conform to the prescribed standards) and adequate for its intended use. Agricultural water use will vary depending on the type of system, which are defined as follows:



- 280
- There are two types of agricultural water systems used in leafy green operations:
- 281     Type A: Agricultural water that is unlikely to contain indicators of fecal contamination either due  
282     to natural hydrogeologic filtration or through controlled USEPA and state regulated treatment  
283     regime as demonstrated by an agricultural water system assessment as outlined in Appendix A,  
284     microbial testing, and when applicable, treatment verification.
- 285     Type B: All other agricultural water systems.
- When determining whether a system is Type A or B, each component (source, storage, conveyance, etc.) must be individually evaluated in typing an entire system.
  - When Type A and B waters are combined, categorize water as Type B.
- 289 2) **Source**: Evaluate each agricultural water source used in your leafy green operations and determine its  
290     type.
- 291     a) Some agricultural water sources are supplied by a third-party provider that certifies the water is of  
292     adequate microbial quality (i.e., unlikely to contain indicators of fecal contamination). Example of  
293     these sources are:
- Public (e.g., municipal) or private providers that deliver certified potable water achieved through treatment or some other process
- 296     b) Some agricultural water sources deliver water of appropriate microbial quality due to natural physical,  
297     chemical, and biological processes that filter water as it passes through the soil. Examples of these  
298     sources for Type A agricultural water systems are:
- Wells constructed in a manner such that contamination from outside sources (e.g., surface water or other surface chemical or biological influences / effects) is unlikely (e.g., well heads are protected, maintained, and monitored; see Appendix A for additional guidance), and water is tested to conform to standards.
  - Regulated recycled water (e.g., tertiary treated, purple pipe, etc.) providers that treat, test, and deliver water that is suitable for use in agricultural applications.<sup>1</sup>
- 305     c) Some agricultural water sources are part of a Type A system due to on-ranch treatment that, when  
306     operating under validated and verifiable parameters, turns Type B water into Type A. An example of a  
307     water source used in a Type B → A agricultural water system is:
- Treated surface water (verified to conform to standards)
- 309     d) Some agricultural water sources are considered part of a Type B system because they are vulnerable  
310     to contamination and have not been treated to ensure human pathogens are not present. For  
311     agricultural water sources requiring a treatment process to meet the proposed standard for overhead

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<sup>1</sup> State regulations vary for recycled water. In some states recycled water for produce production allows a certain level of generic *E. coli*, total coliforms, and/or fecal coliforms.



312 irrigation, a water quality metric based on reduction of total coliform is a good starting point for a  
313 sensible process control strategy. Examples of water sources in a Type B agricultural water system  
314 are:

- 315 • Wells that are contaminated by outside sources including surface waters or by other surface  
316 chemical or biological influences / effects)
- 317 • Untreated surface water

318 3) **Storage and conveyance:** Water source is only one component of an agricultural water system. A water  
319 system that starts out with water of appropriate microbial quality at the source may change quality as it  
320 progresses through the delivery system. Microbial water quality depends on the properties of the water  
321 system's components and how they are maintained (for more on system maintenance, see the section  
322 below on *Best Practice for Managing Storage and Conveyance Systems*). Agricultural water systems are  
323 typically opened or closed. For the purposes of this document, these systems are defined as follows:

- 324 • Closed delivery systems store or convey agricultural water in a manner that does not expose it to the  
325 outside environment and where water maintains the initial source type. Water from closed delivery  
326 systems must be tested at the end of the system to verify water quality is unchanged as it moves  
327 through the system. Additional details about testing requirements for a closed delivery system is  
328 provided in Tables 2A and 2B, and guidance is provided in Appendix A.
- 329 • Open delivery systems, at some point in the system, store or convey agricultural water in a manner  
330 that exposes it to the outside environment (i.e., a reservoir / pond, canal, lateral, uncovered water  
331 tank, etc.). Water in open delivery systems (e.g., reservoirs and ponds) may be used in overhead  
332 applications within 21 days to the scheduled harvest if it is treated (as described in Table 2C) at the  
333 time it is applied to crops. Additional details about testing requirements for an open delivery system is  
334 provided in Table 2D pertaining to Type B agricultural water systems, and guidance is provided in  
335 Appendix A.

## 336 HAZARD ANALYSIS - STEP 2: HOW IS YOUR AGRICULTURAL WATER SYSTEM BEING USED?

337 **Use/Application method:** Risk of leafy green contamination is closely related to *how* water is used in the  
338 production and harvest environment as well as in post-harvest applications (Rock *et al.*, 2019). For this reason,  
339 agricultural water requirements vary depending on *how* it is applied. In leafy green operations, agricultural  
340 water is typically used in aerial (e.g., sprayers, overhead sprinklers, aircraft), ground (e.g., furrow and drip  
341 irrigation), and post-harvest applications. Water is also used for cleaning and, when appropriate, sanitizing  
342 equipment used during production, harvest, and post-harvest activities. Type A, Type B water that is treated  
343 to become Type A (B→A), and Type B agricultural water systems are suitable for specific uses as described in  
344 Table 1.

## 345 HAZARD ANALYSIS - STEP 3: WHEN IS YOUR AGRICULTURAL WATER SYSTEM BEING USED?

346 **Timing of use:** Risk of leafy green contamination is closely related to *when* agricultural water is applied in the  
347 production environment. For this reason, requirements for agricultural water that is aerially applied to leafy  
348 green crops vary depending on *when* the water is applied (Fonseca *et al.*, 2010; Gutierrez-Rodriguez *et al.*,  
349 2012, 2019; Koike *et al.*, 2009; 2010; Moyne *et al.*, 2011; Suslow *et al.*, 2010; Wood *et al.*, 2010).

350 A number of environmental factors, including location of the operation, and the climatic conditions of UV,  
351 relative humidity, precipitation, and temperature, may alter the appropriateness of these time-based



352 requirements. Based on the most appropriate, currently available research addressing the risks related to the  
353 timing of aerial agricultural water application in leafy green operations, time-based requirements are  
354 generally divided as follows:

- 355       ○ Within ( $\leq$ ) 21 days of the scheduled harvest date
- 356       ○ Greater than ( $>$ ) 21 days until the scheduled harvest date
- 357       ● Agricultural water from a Type A system used in overhead irrigation within ( $\leq$ ) 21 days of harvest must  
358       meet the performance requirements for Type A agricultural water systems as outlined in Tables 2A and  
359       2B.
- 360       ● Untreated agricultural water from a Type B system that meets the performance requirements outlined in  
361       Table 2D may be used in aerial applications up until ( $>$ ) 21 days before harvest.
- 362       ● To use agricultural water from a Type B system in overhead irrigation within ( $\leq$ ) 21 days of the scheduled  
363       harvest date, the water must be treated to become Type A water (B $\rightarrow$ A) and demonstrated to meet the  
364       performance requirements as outlined in Table 2C.

365 **TABLE 1. Agricultural Water System Uses by Application Method (for complete requirement details, see**  
366 **Tables 2A-2F)**

Application	Agricultural water systems (possible sources)	Treatment methods for use in direct contact with crop	Microbial indicator
<ul style="list-style-type: none"> <li>● <b>Overhead applications (including irrigation, pesticide spray, aerial chemigation) applied within (<math>\leq</math>) 21 days of scheduled harvest date</b></li> </ul>	Type A agricultural water systems (closed systems including water from wells, municipalities, tertiary treated and disinfected recycled water e.g., purple valve)	No treatment necessary if it can be demonstrated to meet the microbial standards.	<i>generic E. coli</i>
	Treated Type B $\rightarrow$ A agricultural water systems with open components such as reservoirs, ponds, canals, laterals, ditches, etc.	Must be treated and tested to demonstrate treatment efficacy and compliance with microbial standards.	<i>generic E. coli</i> and total coliforms



<ul style="list-style-type: none"> <li>• Overhead irrigation up to (&gt;) 21 days before scheduled harvest date</li> <li>• Germination</li> <li>• Ground chemigation</li> <li>• Drip irrigation</li> <li>• Furrow irrigation</li> <li>• Dust abatement</li> <li>• Non-food contact farm equipment cleaning</li> </ul>	Type A and B water systems	No treatment necessary if it can be demonstrated to meet the microbial standards.	generic <i>E. coli</i>
<ul style="list-style-type: none"> <li>• Food-contact (harvest) equipment cleaning &amp; sanitizing</li> <li>• Hydrovac cooling</li> <li>• Product rehydration</li> <li>• Hydrocooling</li> <li>• Packing ice</li> </ul>	Water that directly contacts edible portions of harvested crop or is used on food-contact surfaces such as equipment or utensils, must meet the Maximum Contaminant Level Goal for <i>E. coli</i> as specified by U.S. EPA or contain an approved antimicrobial treatment at a concentration sufficient to prevent cross-contamination. Microbial or physical/chemical testing shall be performed, as appropriate to the specific operation, to demonstrate that acceptance criteria have been met.		

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## 368 IRRIGATION WATER SAMPLING PLANS AND REMEDIAL ACTIONS

369 Testing agricultural water systems is one method of gathering evidence that your system is of adequate  
 370 quality for its intended use. Along with visual monitoring of agricultural water systems, a water quality  
 371 testing program is a vital best practice for protecting leafy green crops from contamination. To be most  
 372 effective as a food safety tool, water samples must reflect, as much as possible, the water that is contacting  
 373 the crop.

- 374 • As irrigation system equipment may change locations throughout the season, but water sources are  
 375 generally at a fixed location, a robust overhead irrigation water quality testing program must include  
 376 assessments of both the irrigation water source and the irrigation system. Assessing water quality at the  
 377 end of the delivery system ensures source water quality does not degrade as it moves through the  
 378 system.
- 379 • For the purposes of this document, sampling of agricultural water systems occurs for the following three  
 380 reasons and Tables 2A-2E follow this framework providing specific details for each assessment’s  
 381 requirements:
  - 382 ○ **Baseline microbial assessments:** To “type” your agricultural water source and establish its  
 383 “known” quality.
  - 384 ○ **Initial microbial water quality assessment:** To test your agricultural water system prior to use to  
 385 ensure water is not degraded as it moves through the system.



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- **Routine system assessments:** To monitor the microbial quality of your agricultural water *system* throughout the season to ensure it continues to meet the microbial water quality standards.
    - If you are applying water from a Type A agricultural water system greater than (>) 21 days prior to the scheduled harvest date, you may choose to sample and test your water according to Type B criteria rather than according to Type A criteria; however, Type A baseline (when required) and initial microbial water quality assessments must be conducted before the 21 days-before-harvest window closes and routine verification / monitoring begins (per requirements outlined in Tables 2A and 2B).
    - Routine sampling is a part of building a dataset useful for evaluating individual data points and evaluating trends to gain a better understanding of your water system.
      - Non-routine sampling when food safety risks are deemed higher due to specific circumstances (i.e., weather, animal and human activities, discharge, etc.) should also be part of a robust food safety program. In the event that additional risk factors that could affect water quality are observed or measured such as weather, manure application in a nearby field, or animal-related activity, consider conducting additional water testing.
      - If you are irrigating with Type B→A agricultural water systems, collecting and analyzing water system data is essential for understanding of how the treatment functions in your irrigation system and can optimize its effectiveness.
  - All agricultural water systems used in overhead irrigation up to (>) 21 days before the scheduled harvest date must meet the water quality requirements outlined in Table 2D for Type B agricultural water systems.
  - If a Type A or B agricultural water system fails the respective acceptance criteria, follow remedial action steps as outlined in Table 2E (also included in Figures 1B, 2A, 2C and 3B).
  - Retain documentation of all test results and/or Certificates of Analysis/Quality Assurance for a period of at least two (2) years.

#### BEST PRACTICES FOR MANAGING STORAGE AND CONVEYANCE SYSTEMS:

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- Develop a SOP for the maintenance of ancillary equipment and water storage and conveyance components of each agricultural water system used in your operations. The SOP must address:
    - Regularly scheduled visual inspections, including ancillary equipment connected to your storage and conveyance system, to ensure it is in good working order and does not pose a contamination risk to your system.
    - Measures to maintain water quality by removing debris and controlling the presence of weeds, algae, tulle, trash, or debris within the grower's control.
    - Periodic scheduled cleaning and maintenance of reservoirs and canals within the grower's control to eliminate or reduce the presence of algae, which can be conducive to the harborage of harmful bacteria.
    - Procedures to control pest access to the storage and conveyance systems (examples include: avian deterrents, fencing, rodent monitoring).



- 425 ○ Corrective actions to ensure irrigation pipes and drip tape are microbiologically safe to use if a
- 426 pest infestation does occur.
- 427 ○ Berms, slopes and diversion ditches for prevention of run-off (i.e., from irrigation or rain) into
- 428 water storage and conveyance systems.
- 429 ○ Procedures to ensure standing and/or stagnant water does not pose a contamination risk.
- 430 ○ Management of agricultural water system components used to prepare crop amendments to
- 431 ensure these activities and equipment are not a contamination source.
- 432 ○ Water used in aerial applications (e.g., pesticide and fertilizer, etc.) within the 21-days-to-harvest
- 433 window must be from Type A or B→A agricultural water systems. Implement practices to ensure:
  - 434 ▪ Holding tanks and equipment-mounted application tanks, manifold and boom lines, and
  - 435 nozzles are to be properly maintained and cleaned.
  - 436 ▪ Water treatment chemistry is compatible with the agricultural chemicals being applied.
- 437 ○ Establish corrective action procedures for non-compliance scenarios, including:
  - 438 ▪ Contaminated source water
  - 439 ▪ Animal intrusion
  - 440 ▪ Contaminating run-off
- 441 ● Document all corrective measures, cleaning activities, and maintenance.
- 442 ● Establish and implement a SOP to ensure the condition of irrigation equipment does not pose a food
- 443 safety risk.

#### OTHER CONSIDERATIONS FOR WATER

- 445 ● Treat water only with antimicrobial treatments approved by the USEPA for use in agricultural applications
- 446 in accordance with label specifications, guidelines for use, and consideration of environmental impacts.
- 447 ● Antimicrobial treatments must be used and managed in a manner that meets all federal, state, and local
- 448 regulations.
- 449 ● Do not store raw manure or any type of compost near irrigation water sources or conveyance systems
- 450 (see Table 7).



451 The following tables (2A – 2F) refer to agricultural water distribution systems and not to specific ranches, lots,  
 452 fields, etc. The tables outline the metrics for overhead applications of agricultural water sourced from  
 453 public/private supplies (2A), regulated recycled water and private wells (2B), treated water supplies (2C), and  
 454 untreated water that is likely to contain indicators of fecal contamination (2D). Each type of agricultural water  
 455 system must be assessed to demonstrate that the water from the source and the distribution system meet the  
 456 microbial standards. Treated water must be assessed and monitored to demonstrate that the water treatment is  
 457 working as intended and that the treated water meets the microbial standard. Routine monitoring of microbial  
 458 quality is required for all water system types, and remedial actions are required if water testing shows a system  
 459 has failed to deliver water that meets the microbial standard. When performing remedial actions, it is the intent  
 460 that all remedial steps outlined in the tables below are followed and that they are followed in the order of  
 461 sequence as written.

462 **TABLE 2A. Irrigation Water from Type A Agricultural Water Systems Sourced from Public or Private**  
 463 **Providers**

Metric	Rationale /Remedial Actions
<b>Examples of these types of Type A agricultural water systems:</b> Water may come from public and private providers and are stored and conveyed in closed delivery systems.	Irrigation water from Type A agricultural water systems sourced from regulated public or private providers would not be expected to contain generic <i>E. coli</i> due to treatment or some other filtering-type process. Water sourced from a public/private Type A agricultural water provider must be stored and conveyed in well-maintained, closed systems and tested for generic <i>E. coli</i> .
<b>A1. Baseline Microbial Assessment</b>	
A baseline microbial assessment of the water source is not necessary for a Type A system using source water from a public/private provider. In lieu of a baseline microbial assessment, acquire and maintain the supplier’s most current COA on file.	
<b>Records:</b> Records of the analysis of source water may be provided by municipalities, irrigation districts, or other water providers and must be available for verification from the grower/handler who is the responsible party for a period of two years	
<b>A2. Initial Microbial Water Quality Assessment</b>	
<b>Target Organisms:</b> Generic <i>E. coli</i>	
<b>Sampling Procedure:</b> Aseptically collect at least three (3)-100 mL samples during one irrigation event at the end of the delivery system (e.g., last sprinkler head).  <b>Sampling Frequency:</b> This is a one-time seasonal sampling event for each system with samples collected during one irrigation event occurring before the 21-day-to-scheduled-harvest-period begins. (Also conduct	The purpose of this assessment is to confirm that the water’s microbial quality is not being degraded as it passes through your system (i.e., due to equipment conditions). The assessment is performed to verify that your irrigation water delivery system is able to maintain and deliver water of the same microbial quality (e.g., Type A) as the source water. Unless there is a material change to your system (e.g., change in equipment or type of water treatment), this is a one-time assessment for each irrigation system, and it is not necessary to repeat system evaluations for each irrigation event.



<p>this assessment after any material modifications to Type A overhead irrigation systems.)</p> <p><b>Acceptance Criterion - Initial Assessment:</b> Non-detectable in two (2) of three (3)-100 mL samples and 10 MPN as the single sample maximum for one (1) sample.</p> <p><b>Acceptance Criterion - Follow-up Testing:</b> Non-detectable in four (4) of five (5)-100 mL samples and 10 MPN as the single sample maximum for one (1) sample.</p> <p><b>Note:</b> For the purposes of water testing, MPN and CFU are considered equivalent.</p>	<p>To test your water delivery systems, sample and test irrigation water during an irrigation event. All discrete systems are to be tested before entering the 21-days-to-scheduled-harvest timeframe. To assess the water delivery system, water samples are taken at the end of the line where water contacts the crop.</p> <p><u>Initial Assessment Testing</u></p> <p>If at least two (2) in three (3) samples do not have detectable levels of generic <i>E. coli</i>, and the level in the one remaining sample is no greater than (<math>\leq</math>) 10 MPN, then the water system maintains its Type A status.</p> <p>If water samples do not meet the acceptance criteria (i.e., if two (2) or more of the samples have detectable levels of generic <i>E. coli</i> <u>or</u> the level in at least one sample is greater than (<math>&gt;</math>) 10 MPN), then conduct the following follow-up testing:</p> <p><u>Follow-up Testing</u></p> <ol style="list-style-type: none"><li>1) Pause irrigation and perform a root cause analysis and an agricultural water system assessment as described in Appendix A to identify and correct the failure.</li><li>2) After assessing the system, retest the system for generic <i>E. coli</i> in five (5)-100 mL samples collected during the next irrigation event using the sampling procedure and frequency (described in the left column). Water samples can be pulled from the end of any system nodes/branches in the irrigation system of concern. Of the five (5) follow-up samples, four (4) must have no detectable generic <i>E. coli</i> and the one (1) remaining sample must have levels no greater than (<math>\leq</math>) 10 MPN / 100 mL.</li><li>3) If test results meet the acceptance criterion for generic <i>E. coli</i>, the water system can be used as a Type A system.</li></ol> <p><u>Testing Failure:</u> When one sample has more than (<math>&gt;</math>) 10 MPN / 100 mL or more than one sample have detectable generic <i>E. coli</i>, the agricultural water system is disqualified for Type A usage. Perform a root cause analysis to identify and correct the failure (see Appendix A for mitigation measures). In the interim, the water can be used as a Type B agricultural water system.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	

<sup>2</sup> Equivalent testing methodology for agricultural water  
<https://www.fda.gov/food/foodscienceresearch/laboratorymethods/ucm575251.htm>



**Records:** Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.

**A3. Routine Verification of Microbial Water Quality**

**Sampling Procedure**

Three (3)-100 mL sample aseptically collected at the end of the delivery system (e.g., the last sprinkler head).

**Sampling Frequency**

Sample and test each distinct irrigation system for generic *E. coli* at least once during the season.

**Acceptance Criterion**

Non-detectable generic *E. coli* in 100 mL water samples and  $\leq 10$  MPN as the single sample maximum for one (1) in five (5) samples

**Note:** For the purposes of water testing, MPN and CFU are considered equivalent.

To verify irrigation water continues to meet the acceptance criterion throughout the season, design your sampling plan so each distinct irrigation system that is in use is sampled and tested at least once during the season.

To evaluate your water quality, use the last two consecutive values from your last sampling event as well as the current three (3) samples. If at least four (4) of these five (5) consecutive samples (80%) do not have detectable levels of generic *E. coli*, and the level in the one remaining sample is no greater than ( $\leq$ ) 10 MPN, then the water system maintains its Type A status.

If two (2) or more of the samples have detectable levels of generic *E. coli* or the level in at least one sample is greater than ( $>$ ) 10 MPN, pause irrigation and perform a Level 1 Assessment as outlined in Table 2E.

**Test Method:** Any FDA-allowed method<sup>2</sup>

**Records:** Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.

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466 FIGURE 1A. Irrigation Water from Type A Agricultural Water Systems Sourced from Public / Private  
467 Suppliers

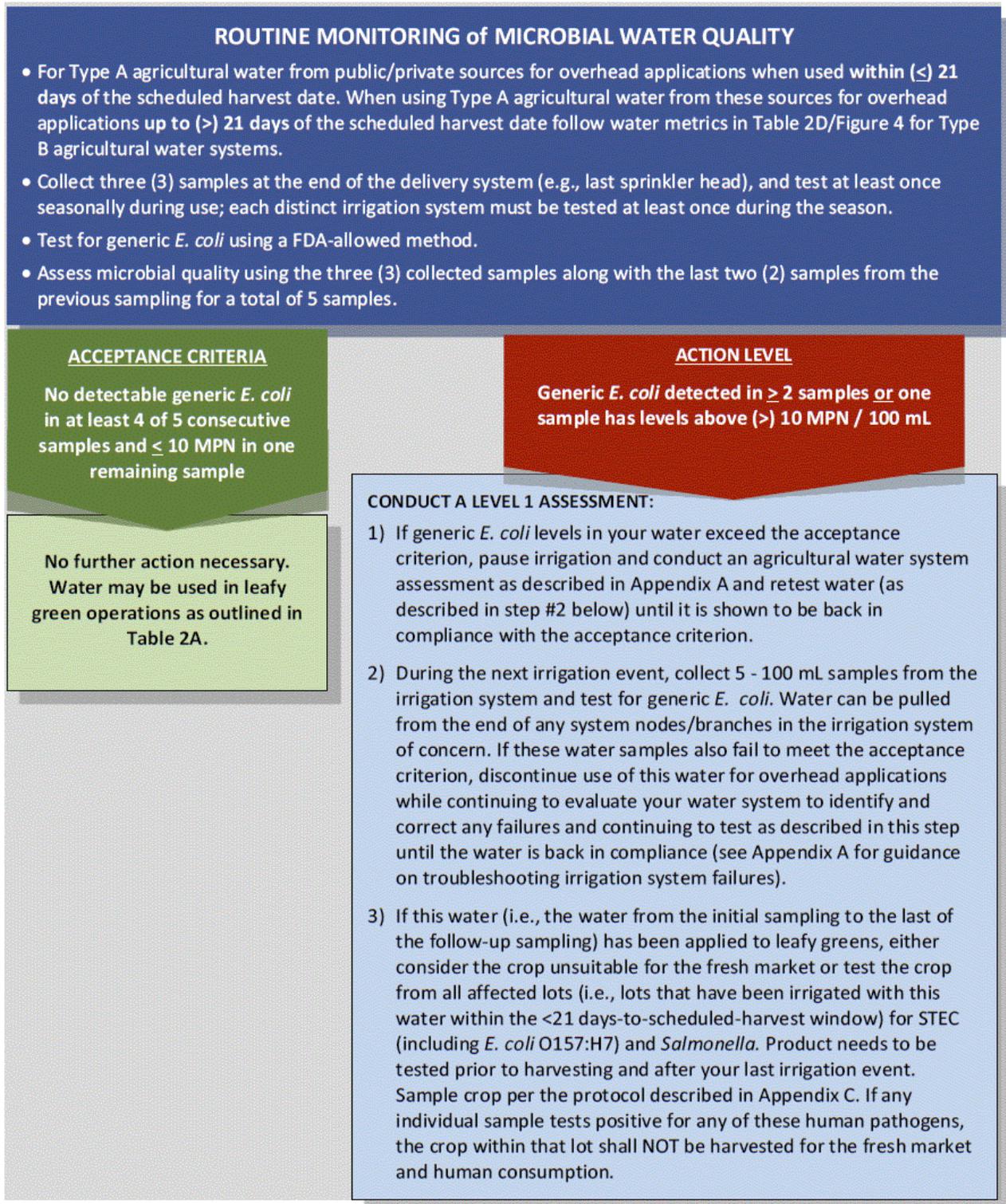


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FIGURE 1B. Irrigation Water from Type A Agricultural Water Systems Sourced from Public / Private



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TABLE 2B. Irrigation Water from Type A Agricultural Water Systems Sourced from Private Wells or Regulated Tertiary Treated Recycled Water Supplies

Metric	Rationale /Remedial Actions
<p><b>Examples of water from Type A agricultural water systems:</b></p> <ul style="list-style-type: none"> <li>• Regulated recycled waste water</li> <li>• Water sourced from a well – well water is conveyed to the field in a closed delivery system and applied to the crop via overhead sprinklers.</li> </ul>	<p>Irrigation water from Type A agricultural water systems with well source water would not be expected to contain generic <i>E. coli</i> due to natural filtration as the water passes through the soil. Water from regulated tertiary treated recycled water supplies may have low levels of generic <i>E. coli</i> due to regulatory allowable limits. Type A agricultural water systems must be stored and conveyed in well-maintained, closed systems and tested for generic <i>E. coli</i>. Remedial actions vary depending on when the water is being used in relation to harvest.</p>
<p><b>B1. Baseline Microbial Assessment</b></p>	
<p><b>Target Organisms:</b> Generic <i>E. coli</i></p>	
<p><b>Sampling Procedure:</b> If historical water test data is not available, aseptically collect at least three (3)-100 mL sample at the source.</p> <p><b>Sampling Frequency:</b> Sample and test the water two times (with sampling events separated by no less than 7 days) before using the water within the 21 days-to-scheduled-harvest-window.</p> <p><b>Acceptance Criteria:</b> Non-detectable generic <i>E. coli</i> in five (5) of six (6) 100 mL samples and ≤ 10 MPN as the single sample maximum for one (1) sample.</p> <p><b>Note:</b> For the purposes of water testing, MPN and CFU are considered equivalent.</p>	<p>The purpose of a baseline assessment is to ensure your water source (e.g., a well or regulated tertiary treated recycled water) meets the microbial standards for generic <i>E. coli</i>. This baseline microbial assessment must be conducted before these Type A water sources can be used for overhead irrigation within 21 days to scheduled harvest.</p> <p><u>Self-certification with historical water test data:</u> If at least four (4) of the last five (5) consecutive historical water tests (80%) have no detectable generic <i>E. coli</i>, the remaining one (1) sample does not exceed (≤) 10 MPN in 100 mL, and one (1) of those tests was taken within the last 6 months, then the well/regulated tertiary treated recycled water supply is self-certified as a Type A agricultural water source.</p> <p><u>Self-certification process when no historical data is available:</u> If historical data is unavailable, test the well or regulated recycled water twice (separated by no less than seven days) prior to use as the source water for a Type A agricultural water system. If at least five (5) of the six (6) total samples have no detectable generic <i>E. coli</i> and the remaining sample has ≤ 10 MPN in 100 mL, then the water/well is self-certified as a Type A agricultural water source.</p> <p><u>Testing Failure:</u> If test results do not meet the acceptance criteria, then the water/well cannot be considered a Type A agricultural water source. Perform a root cause analysis and an agricultural water system assessment as described in Appendix A to identify and correct the failure. In the interim, the water can be treated or used as a source for a Type B agricultural water system.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	



**Records:** Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.

**B2. Initial Microbial Water Quality Assessment**

**Target Organism:** Generic *E. coli*

**Sampling Procedure:**

Aseptically collect at least three (3)-100 mL during one irrigation event at the end of the delivery system (e.g., last sprinkler head).

**Sampling Frequency:**

This is a one-time seasonal sampling event for each system with samples collected during one irrigation event occurring before the 21-day-to-scheduled-harvest-period begins. (Also conduct this assessment after any material modifications to Type A overhead irrigation systems.)

**Acceptance Criterion – Initial Assessment:**

Non-detectable generic *E. coli* in two (2) of three (3)-100 mL samples and  $\leq$  10 MPN as the single sample maximum for one (1) sample.

**Acceptance Criterion – Follow-up Testing:**

Non-detectable in four (4) of five (5)-100 mL samples and  $\leq$  10 MPN as the single sample maximum for one (1) sample.

**Note:** For the purposes of water testing, MPN and CFU are considered equivalent.

The purpose of this assessment is to confirm that the water’s microbial quality is not being degraded as it passes through your system (i.e., due to equipment conditions). The assessment is performed to verify that your irrigation water delivery system is able to maintain and deliver water of the same microbial quality (e.g., Type A) as the source water. Unless there is a material change to your system (e.g., change in equipment or type of water treatment), this is a one-time assessment for each irrigation system, and it is not necessary to repeat system evaluations for each irrigation event.

To test your water delivery systems, sample and test irrigation water during an irrigation event. All discrete systems are to be tested before entering the 21-days-to-scheduled-harvest timeframe. To assess the water delivery system, water samples are taken at the end of the line where water contacts the crop.

Initial Assessment Testing

If at least two (2) in three (3) samples do not have detectable levels of generic *E. coli*, and the level in the one remaining sample is no greater than ( $\leq$ ) 10 MPN, then the water system maintains its Type A status.

If water samples do not meet the acceptance criteria (i.e., if two (2) or more of the samples have detectable levels of generic *E. coli* or the level in at least one sample is greater than ( $>$ ) 10 MPN), then conduct the following follow-up testing:

Follow-up Testing

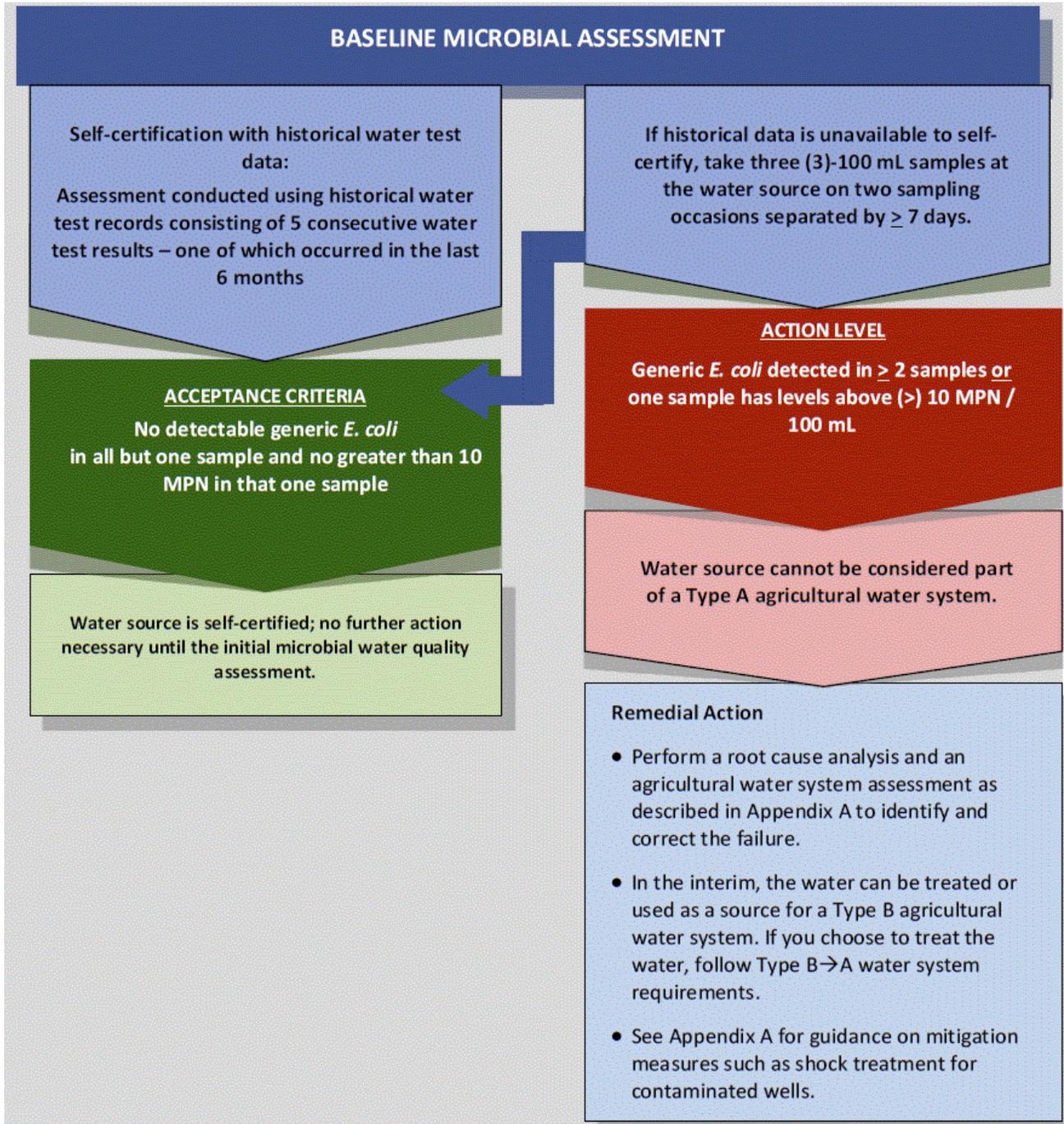
- 1) Pause irrigation and perform a root cause analysis and an agricultural water system assessment as described in Appendix A to identify and correct the failure.
- 2) After assessing the system, retest the system for generic *E. coli* in five (5)-100 mL samples collected during the next irrigation event using the sampling procedure and frequency (described in the left column). Water samples can be pulled from the end of any system nodes/branches in the irrigation system of concern. Of the five (5) follow-up samples, four (4) must have no detectable generic *E. coli* and the one (1) remaining sample must have levels no greater than ( $\leq$ ) 10 MPN / 100 mL.



	<p>3) If test results meet the acceptance criterion for generic <i>E. coli</i>, the water system can be used as a Type A system.</p> <p><u>Testing Failure:</u> When one sample has more than (&gt;) 10 MPN / 100 mL or more than one sample have detectable generic <i>E. coli</i>, the agricultural water system is disqualified for Type A usage. Perform a root cause analysis to identify and correct the failure (see Appendix A for mitigation measures). In the interim, the water can be used as a Type B agricultural water system.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	
<p><b>Records:</b> Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.</p>	
<p><b>B3. Routine Verification of Microbial Water Quality</b></p>	
<p><b>Target Organisms:</b> Generic <i>E. coli</i></p>	
<p><b>Sampling Procedure</b> Three (3)-100 mL sample aseptically collected at the end of the delivery system (e.g., the last sprinkler head).</p> <p><b>Sampling Frequency</b> Sample and test each distinct irrigation system for generic <i>E. coli</i> at least once during the season.</p> <p><b>Acceptance Criterion</b> Non-detectable generic <i>E. coli</i> in 100 mL water samples and ≤ 10 MPN as the single sample maximum for one (1) in five (5) samples</p> <p><b>Note:</b> For the purposes of water testing, MPN and CFU are considered equivalent.</p>	<p>To verify irrigation water continues to meet the acceptance criterion throughout the season, design your sampling plan so each distinct irrigation system that is in use is sampled and tested at least once during the season.</p> <p>To evaluate your water quality, use the last two consecutive values from your last sampling event as well as the current three (3) samples. If at least four (4) of these five (5) consecutive samples (80%) do not have detectable levels of generic <i>E. coli</i>, and the level in the one remaining sample is no greater than (≤) 10 MPN, then the water system maintains its Type A status.</p> <p>If two (2) or more of the samples have detectable levels of generic <i>E. coli</i> <u>or</u> the level in at least one sample is greater than (&gt;) 10 MPN, pause irrigation and perform a <b>Level 1 Assessment</b> as outlined in Table 2E.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	
<p><b>Records:</b> Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.</p>	



477 FIGURE 2A. Irrigation Water from Type A Agricultural Water Systems Sourced from Private Wells or  
478 Regulated Tertiary Treated Recycled Water Supplies



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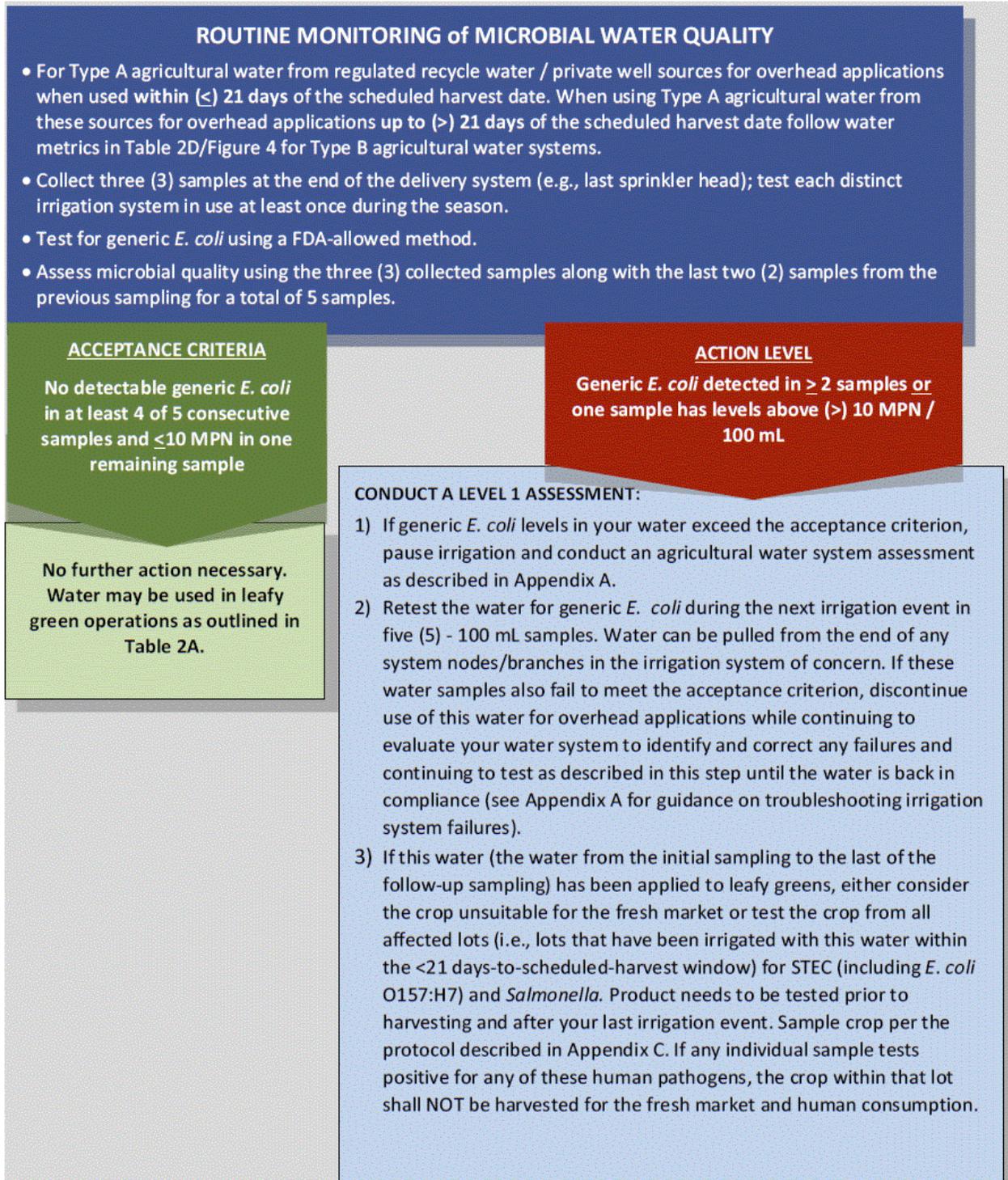
482 FIGURE 2B. Irrigation Water from Type A Agricultural Water Systems Sourced from Private Wells or  
483 Regulated Tertiary Treated Recycled Water Supplies  
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487 FIGURE 2C. Irrigation Water from Type A Agricultural Water Systems Sourced from Private Wells or  
488 Regulated Tertiary Treated Recycled Water Supplies



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TABLE 2C. Irrigation Water from Treated Type B→A Agricultural Water Systems

Metric	Rationale /Remedial Actions
<p><b>Example of treated water from a Type B→A agricultural water system:</b> Water may arrive at the production area in an irrigation district canal or lateral from which it is pumped and treated before being used in overhead sprinkler irrigation.</p>	<p>When water from a Type B agricultural water system is used in an overhead application within (<math>\leq</math>) 21 days to the scheduled harvest date, it must be treated to move it from a Type B agricultural water system to a Type A system (B→A) by a scientifically valid antimicrobial treatment - i.e., contain an approved antimicrobial treatment at sufficient concentration to prevent potential contamination risk during overhead applications.</p> <p>Physical/chemical testing of the source and system must be performed, as appropriate to the specific operation, to demonstrate that performance criteria have been met before use within (<math>\leq</math>) 21 days to the scheduled harvest date and continues to be met throughout its use.</p> <p>Water in open delivery systems (e.g., reservoirs and ponds) may be used in overhead applications within 21 days to the scheduled harvest if it is treated at the same time it is applied to crops.</p>
<p><b>C1. Initial Irrigation Water Treatment Assessment</b></p>	
<p><b>Target Variable:</b> Antimicrobial treatment parameters (e.g., chlorine or other antimicrobial treatment concentration, other per manufacturer’s recommendations).</p>	
<p><b>Antimicrobial treatments:</b> USEPA-approved for use in agricultural water.</p> <p><b>Sampling Procedure:</b> To conduct the assessment, begin sampling after your irrigation system has stabilized (i.e., all lines are pressurized, and the calculated feed-rate is verified). Test the water at least three (3) times at the manufacturer’s recommended sampling location in the delivery system (e.g., first or last sprinkler head).</p> <p><b>Sampling Frequency:</b> This is a one-time seasonal testing event for each treatment system conducted during one irrigation event occurring before the 21-day-to-scheduled-harvest-period begins. Sample the water at least three (3) times at least 20 minutes apart.</p> <p><b>Acceptable Performance Criteria:</b> Per label instructions on parameters indicating treatment (e.g., sanitizer) effectiveness (e.g., chemical break point).</p>	<p>This one-time initial assessment must be completed on each irrigation system delivering treated water to crops before entering the 21-days-to-scheduled-harvest timeframe. Before using treated water to irrigate crops within the (<math>\leq</math>) 21 days-to-scheduled-harvest timeframe, growers must first establish SOPs outlining the following about their irrigation system and treatment process:</p> <ul style="list-style-type: none"> <li>▪ The irrigation system parameters, such as water flow rate, distance from the treatment to the first sprinkler, the pipe diameter, etc. that are required to set up and run the treatment system.</li> <li>▪ The treatment process parameters such as antimicrobial dosing unit settings, pH, residual antimicrobial level at discharge point (first sprinkler), and any other parameter as needed that will be monitored to ensure consistent treatment delivery and to demonstrate its effectiveness in meeting the microbial requirements.</li> </ul>



**Records:** Document treatment-related parameter values such as antimicrobial levels, pH, dose settings, etc. to demonstrate the system is working as intended. Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.

## C2. Initial Microbial Water Quality Assessment

### Target Organisms:

- Total coliforms (TC)
- Generic *E. coli*

### Sampling Procedure:

Collect at least three (3)-100 mL samples at the end of the delivery system (e.g., last sprinkler head).

### Sampling Frequency:

This is a one-time seasonal sampling event conducted for each irrigation system during one irrigation event occurring before the 21-day-to-scheduled-harvest-period begins. Collect the three (3)-100 mL samples no closer than 20 minutes apart. (Also conduct this assessment after any material modifications to Type A overhead irrigation systems.)

### Acceptance Criteria – Initial Assessment

In three (3) consecutive samples:

**Total coliform:** A maximum level of  $\leq 99$  MPN in 100 mL or an adequate log reduction based on the untreated water's baseline total coliform levels\*

**Generic *E. coli*:** No detection in two (2) of three (3) samples with a maximum level of  $\leq 10$  MPN allowed in one (1) sample

### Acceptance Criteria – Follow-up Testing

Non-detectable in four (4) of five (5)-100 mL samples and  $\leq 10$  MPN as the single sample maximum for one (1) sample.

The purpose of this assessment is to confirm that the water's microbial quality is not being degraded as it passes through your system (i.e., due to equipment conditions). The assessment is performed to verify that your irrigation water delivery system is able to maintain and deliver water of the same microbial quality (e.g., Type A) as the source water. Unless there is a material change to your system (e.g., change in equipment or type of water treatment), this is a one-time assessment for each irrigation system, and it is not necessary to repeat system evaluations for each irrigation event.

To test your water delivery systems, sample and test irrigation water during an irrigation event. All discrete systems are to be tested before entering the 21-days-to-scheduled-harvest timeframe. To assess the water delivery system, water samples are taken at the end of the line where water contacts the crop.

#### Initial Assessment Testing

After activating and stabilizing your treatment system (i.e., all lines are pressurized and the performance-established feed-rate is verified), sample and test the treated water source for total coliform and generic *E. coli* in three (3)-100 mL samples. To maintain its Type A status, water samples must have:

- total coliform at a level no greater than ( $\leq$ ) 99 MPN in 100 mL \*, and
- no detectable generic *E. coli* in at least two (2) of the three (3) samples with a maximum level no greater than ( $\leq$ ) 10 MPN in the remaining sample.

\* As an alternative to the threshold approach for total coliform ( $\leq 99$  MPN / 100 mL), operators can verify their treatment system by conducting paired pre- and post-treatment microbial testing of source water (see Appendix A for additional guidance on conducting a log reduction assessment).

If two (2) or more of the three (3) water samples do not meet the acceptance criterion for total coliform or generic *E. coli* or the generic *E. coli* level in at least one sample is greater than ( $>$ ) 10 MPN, then conduct the following follow-up tests:

#### Follow-up Testing



<p><b>Note:</b> For the purposes of water testing, MPN and CFU are considered equivalent.</p>	<ol style="list-style-type: none"> <li>1) Pause irrigation and perform a root cause analysis and an agricultural water system assessment as described in Appendix A to determine why the treatment was not effective and correct the failure.</li> <li>2) After assessing the system, retest the system for total coliform and generic <i>E. coli</i> in five (5)-100 mL samples collected during the next irrigation event using the sampling procedure and frequency (described in the left column). Water samples can be pulled from the end of any system nodes/branches in the irrigation system of concern. If test results meet the acceptance criteria for total coliform and generic <i>E. coli</i>, the water system can be used as a Type A treated system.</li> </ol> <p><u>Testing Failure</u></p> <p>If test results exceed the acceptance criteria for TC <u>or</u> generic <i>E. coli</i>, then the system is not considered acceptable for a treated Type B→A agricultural water system. Perform a root cause analysis to identify why the treatment was not effective and correct the failure. In the interim, the water can be used as a source for a Type B agricultural water system.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	
<p><b>Records:</b> Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.</p>	
<p><b>C3. Routine Verification of Microbial Water Quality</b></p>	
<p><b>Target Organisms:</b></p> <ul style="list-style-type: none"> <li>• Total coliforms (TC)</li> <li>• Generic <i>E. coli</i></li> </ul>	
<p><b>Sampling Procedure:</b></p> <p>For each sampling event, aseptically collect at least three (3)-100 mL samples at the manufacturer’s recommended sampling location in the delivery system (e.g., first or last sprinkler head).</p> <p><b>Sampling Frequency</b></p> <p>Sampling is conducted monthly.</p> <p>If the irrigation system is being used prior to the 21-days-to-harvest-window, sample and test each distinct irrigation system on at least one occasion.</p> <p>If the irrigation system is being used within the 21-days-to-harvest-window, sample each distinct irrigation system on</p>	<p>Routine water sampling is performed to verify irrigation water continues to meet the microbial quality acceptance criteria throughout the season. Routine verification of treated irrigation water systems is focused on the function of the system. Sampling needs to occur at a frequency that allows operators to verify they have control of their treatment system. An essential component of this verification process is building a dataset so microbial quality can be analyzed to best inform you how to effectively run your water treatment system.</p> <p>To evaluate your water quality, use the last two consecutive values from your previous sampling event as well as the current three (3) samples taken during this sampling event. To maintain its Type A status, at least four (4) of the last five (5) consecutive water samples (80%) must have:</p> <ul style="list-style-type: none"> <li>▪ total coliform with a maximum level no greater than (<math>\leq</math>) 99 MPN, and</li> <li>▪ no detectable generic <i>E. coli</i> with a maximum level no greater than (<math>\leq</math>) 10 MPN in the remaining sample.</li> </ul> <p>If two (2) or more of the five samples do not meet the acceptance criteria for total coliform or generic <i>E. coli</i> or the generic <i>E. coli</i> level in at least one</p>



<p>at least two occasions separated by at least three (3) days.</p> <p><b>Acceptance Criteria</b></p> <p><u>Total coliform</u>: A maximum level of <math>\leq 99</math> MPN in 100 mL in all water samples or an adequate log reduction based on the untreated water's baseline total coliform levels*</p> <p><u>Generic <i>E. coli</i></u>: No detection in four (4) of the last five (5) consecutive water samples with a maximum level of (<math>\leq</math>) 10 MPN allowed in one (1) sample</p> <p><b>Note:</b> For the purposes of water testing, MPN and CFU are considered equivalent.</p>	<p>sample is greater than (<math>&gt;</math>) 10 MPN, pause irrigation and perform a <b>Level 1 Assessment</b> as outlined in Table 2E.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	
<p><b>Records:</b> Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.</p>	
<p><b>C4. Routine Treatment Monitoring</b></p>	
<p><b>Antimicrobial treatments</b> - USEPA-approved for use in agricultural water.</p> <p><b>Target Variable:</b> Antimicrobial treatment (e.g., per manufacturer's recommendations, chemical concentration, etc.).</p>	
<p><b>Testing Procedure:</b></p> <ul style="list-style-type: none"> <li>• Chemical reaction-based colorimetric test, or</li> <li>• Ion-specific probe, or</li> <li>• Other as recommended by antimicrobial treatment supplier.</li> </ul> <p><b>Testing Frequency:</b></p> <p>Monitoring must be conducted whenever the irrigation system is in use. Continuous monitoring (preferred) with periodic verification by titration <b>OR</b> routine monitoring if the system can be shown to have a low degree of variation.</p>	<p>Monitor the efficacy of the water treatment method per the manufacturer's (label) instructions.</p> <p>To demonstrate the system is performing as intended <u>during each irrigation event</u>, document:</p> <ul style="list-style-type: none"> <li>• Flow rates</li> <li>• Treatment-related parameters such as antimicrobial levels, pH, dose settings, etc.</li> </ul> <p>If water quality falls outside the acceptable parameters, conduct a microbial test per the routine microbial assessment requirements outlined in section C3.</p>
<p><b>Test Method:</b> Per label instructions</p>	



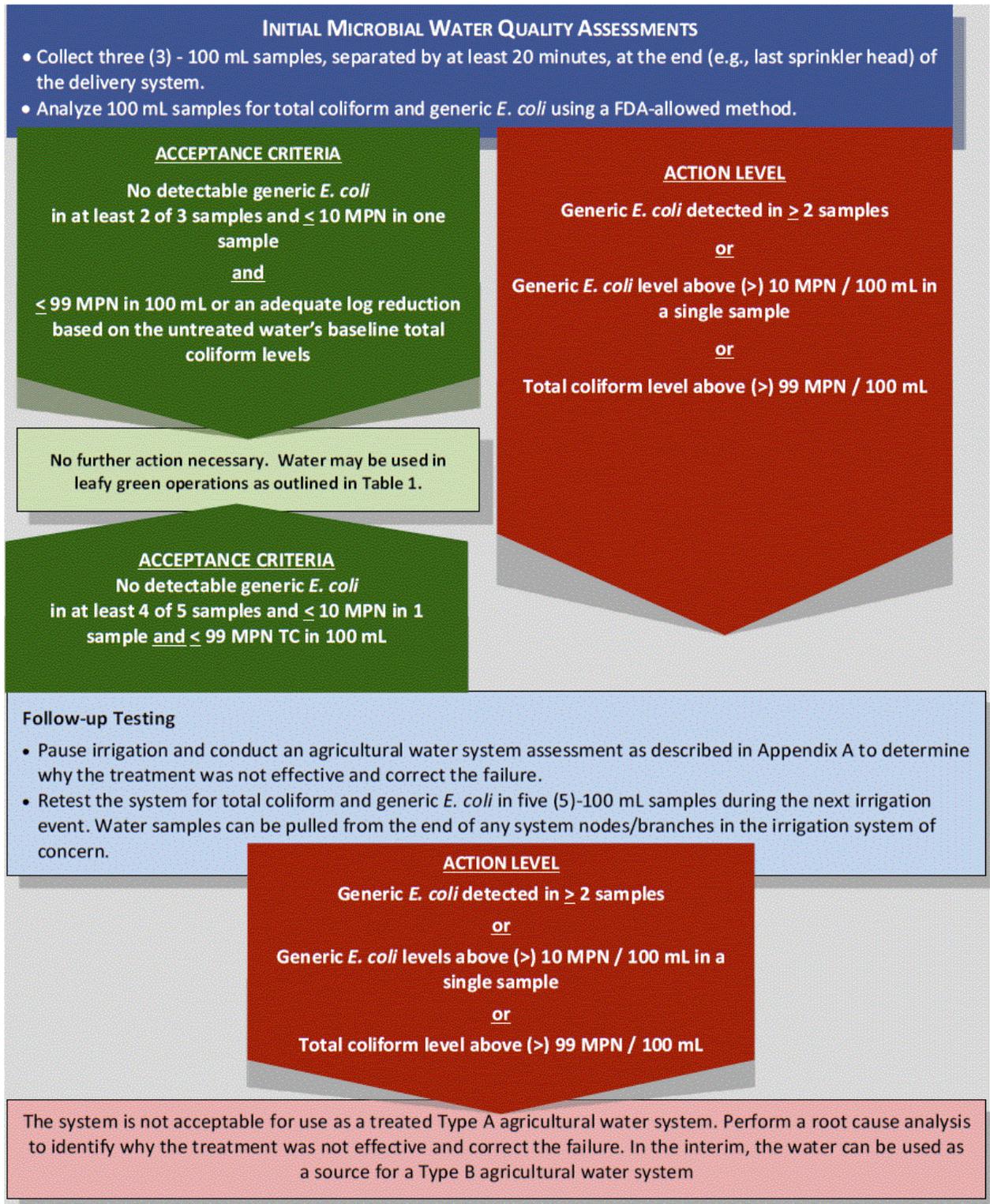
**Records:** During every irrigation event, treatment-related parameter values such as antimicrobial levels, pH, dose settings, etc. must be documented to demonstrate the system is working as intended. Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.

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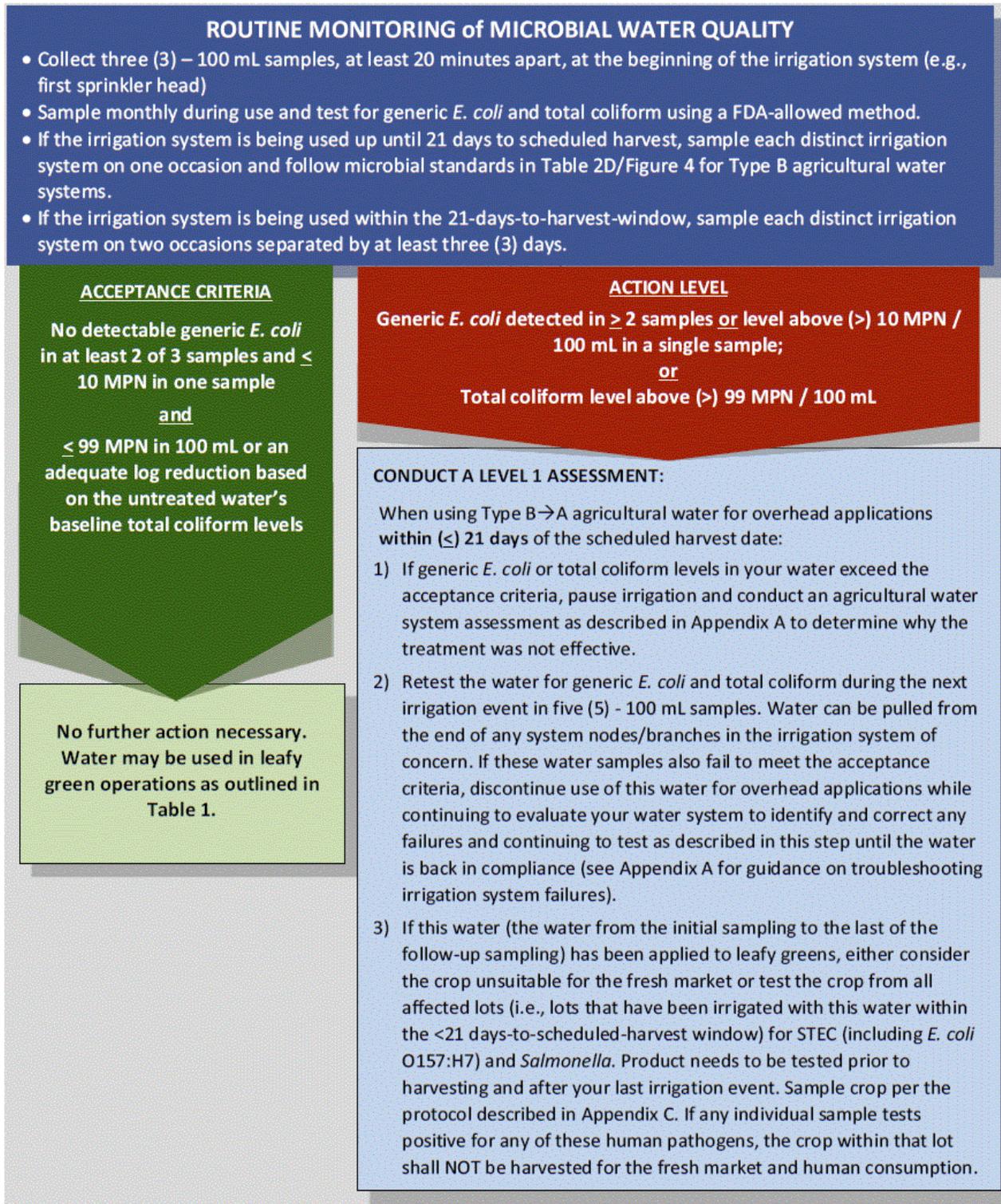
493 FIGURE 3A. Irrigation Water from Type B→A (Treated) Agricultural Water Systems





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FIGURE 3B. Irrigation Water from Type B→A (Treated) Agricultural Water Systems



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497 TABLE 2D. Irrigation Water from Type B Agricultural Water Systems

Metric	Rationale /Remedial Actions
<p><b>Example of water from a Type B agricultural water system</b> - water may arrive at the field in an irrigation district canal from which it is then used to overhead irrigate crop up until 21 days to the scheduled harvest date.</p>	<p>Water from Type B agricultural water systems is untreated and exposed to the environment (e.g., open sources and/or delivery systems) so that its quality may be inadequate for overhead irrigation within (<math>\leq</math>) 21 days to harvest. Water from these systems is restricted to use in overhead irrigation when applied up to (<math>&gt;</math>) 21 days to the scheduled harvest date.</p> <p>Also, water from Type A agricultural water systems can be sampled and tested under Type B agricultural water system requirements when it is used for overhead irrigation greater than 21 days before the scheduled harvest date.</p>
<p><b>D1. Routine Verification of Microbial Water Quality</b></p>	
<p><b>Target Organisms:</b> Generic <i>E. coli</i></p>	
<p><b>Sampling Procedure:</b> <u>100 mL sample collected aseptically at the point-of-use; i.e., one sprinkler head per water source for irrigation, water tap for pesticides, etc.</u> Water used in preseason irrigation operations may be tested and utilized.</p> <p><b>Sampling Frequency:</b> One sample per water source shall be collected and tested prior to use if <math>&gt;</math> 60 days since last test of the water source. Additional samples shall be collected no less than 18 hrs. apart and at least monthly during use from points within the distribution system.</p> <p><b>Acceptance Criterion:</b> <math>&lt;</math> 126 MPN / 100 mL (geometric mean) and <math>\leq</math> 235 MPN/100mL for any single sample.</p> <p><b>Note:</b> For the purposes of water testing, MPN and CFU are considered equivalent.</p>	<p>When using water from Type B agricultural water systems for overhead applications <b>up to (<math>&gt;</math>) 21 days</b> of the scheduled harvest date, samples for microbial testing shall be taken at the point-of-use (i.e., to be determined by the sampler, to ensure the integrity of the sample, using sampling methods as prescribed in Table 2D) where the water contacts the crop, so as to test both the water source and the water distribution system. In a closed water system (meaning no connection to the outside) water samples may be collected from any point within the system but are still preferred at the point-of-use. No less than one (1) sample per month per distribution system is required under these metrics. If there are multiple potential point-of-use sampling points in a distribution system, then samples shall be taken from different point-of-use locations each subsequent month (randomize or rotate sample locations).</p> <p>Water for pre-harvest, direct edible portion contact up to (<math>&gt;</math>) 21 days before scheduled harvest shall meet or exceed microbial standards for recreational water, based on a rolling geometric mean of the five (5) most recent samples. However, a rolling geometric mean of five samples is not necessarily required prior to irrigation or harvest. If less than five (5) samples are collected prior to irrigation, the acceptance criteria depend on the number of samples taken. For example:</p> <ul style="list-style-type: none"> <li>▪ If only one (1) sample has been taken, it must be below (<math>&lt;</math>) 126 MPN /100 mL.</li> <li>▪ Once two (2) samples are taken, a geometric mean can be calculated, and the normal acceptance criteria apply.</li> </ul> <p>If the acceptance criteria are exceeded during this time period, additional samples may be collected to reach a five (5)-sample rolling geometric mean (as long as the water has not been used for irrigation). The <i>rolling</i> geometric mean calculation starts after five (5) samples have been collected. If the water source has not been tested in the past 60 days, the first water sample</p>



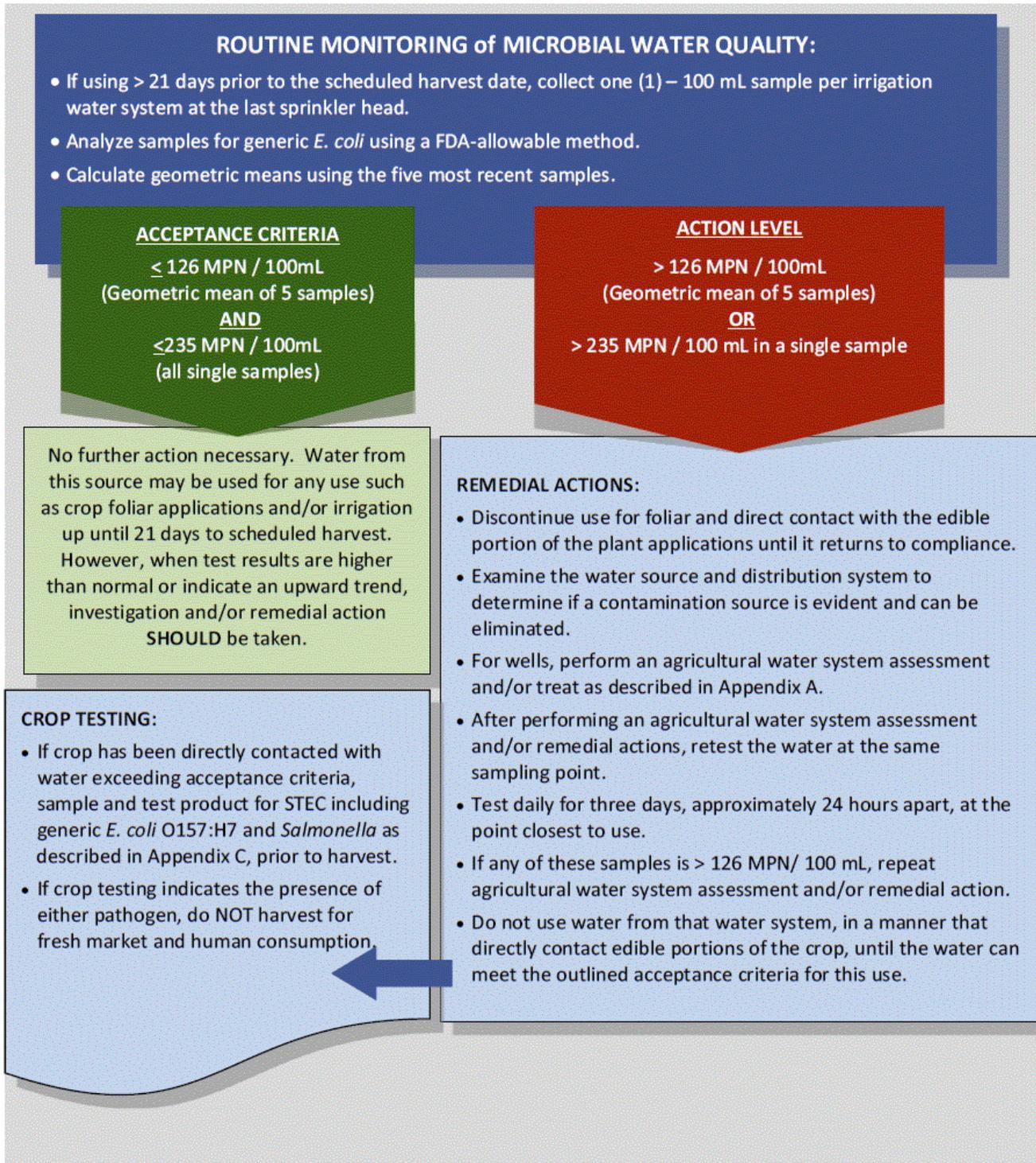
	<p>shall be tested prior to use, to avoid using a contaminated water source. After the first sample is shown to be within acceptance criteria, subsequent samples shall be collected no less frequently than monthly at points-of-use within the distribution system.</p> <p>Ideally, pre-harvest water used up to 21 days before harvest for overhead applications should not contain generic <i>E. coli</i>, but low levels do not necessarily indicate that the water is unsafe. Investigation and/or remedial action SHOULD be taken when test results are higher than normal or indicate an upward trend. Investigation and remedial action SHALL be taken when acceptance criteria are exceeded.</p> <p><b>Remedial Actions:</b> If the rolling geometric mean (n=5) or any one sample exceeds the acceptance criteria, then the water shall not be used whereby edible portions of the crop are contacted by water until remedial actions have been completed and generic <i>E. coli</i> levels are within acceptance criteria:</p> <ul style="list-style-type: none"><li>• Conduct an agricultural water system assessment of water source and distribution system to determine if a contamination source is evident and can be eliminated. Eliminate identified contamination source(s).</li><li>• For wells, perform an agricultural water system assessment and/or treat as described in Appendix An agricultural water system assessment.</li></ul> <p>Retest the water after conducting the agricultural water system assessment and/or taking remedial actions to determine if it meets the outlined microbial acceptance criteria for this use. This sample should represent the conditions of the original water system, if feasible this test should be at the original sampling point. A more aggressive sampling program (i.e., sampling once per week instead of once per month) shall be instituted if an explanation for the exceedance is not readily apparent. This type of sampling program should also be instituted if an upward trend is noted in normal sampling results.</p>
<p><b>Test Method:</b> Any FDA-allowed method<sup>2</sup></p>	
<p><b>Records:</b> Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.</p>	

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500 FIGURE 4. Irrigation Water from Type B Agricultural Water Systems



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TABLE 2E. Remedial Actions for Type A and B→A Agricultural Water Systems

<b>Level 1 Assessment</b>	
<b>Target Organisms:</b> Generic <i>E. coli</i>	
<p><b>Sampling Procedure:</b> Aseptically collect five (5)-100 mL sample at the end of the delivery system, i.e., at the last point of contact with the crop - last sprinkler head.</p> <p><b>Sampling Frequency:</b> Sample water during the next consecutive irrigation event after a sample fails the acceptance criterion.</p> <p><b>Acceptance Criterion:</b> 80% non-detectable generic <i>E. coli</i> in 100 mL and <math>\leq 10</math> MPN as the single sample maximum for one (1) sample</p>	<p>When using water from Type A and/or B→A agricultural water systems for overhead applications <b>within (<math>\leq</math>) 21 days</b> of the scheduled harvest date:</p> <ol style="list-style-type: none"> <li>1) If generic <i>E. coli</i> levels in your water exceed the acceptance criterion, pause irrigation and conduct an agricultural water system assessment as described in Appendix A and retest water (as described in step #2 below) until it is shown to be back in compliance with the acceptance criterion.</li> <li>2) During the next irrigation event, collect five (5)-100 mL samples from the irrigation system and test for generic <i>E. coli</i>. Water can be pulled from the end of any system nodes/branches in the irrigation system of concern. If these water samples also fail to meet the acceptance criterion, discontinue use of this water for overhead applications while continuing to evaluate your water system to identify and correct any failures and continuing to test as described in this step until the water is back in compliance (see Appendix A for guidance on troubleshooting irrigation system failures).</li> <li>3) If this water (the water from the initial sampling to the last of the 2<sup>nd</sup> round sampling) has been applied to leafy greens, either consider the crop unharvestable or test the crop from all affected lots (i.e., lots that have been irrigated with this water within the &lt;21 days-to-scheduled-harvest window) for STEC (including <i>E. coli</i> O157:H7) and <i>Salmonella</i>. Product needs to be tested prior to harvesting and after your last irrigation event. Sample crop per the protocol described in Appendix C. If any individual sample tests positive for any of these human pathogens, the crop within that lot shall NOT be harvested for human consumption.</li> </ol> <p>When using agricultural water systems for overhead applications <b>up to (<math>&gt;</math>) 21 days</b> of the scheduled harvest date:</p> <ul style="list-style-type: none"> <li>• Follow water metrics in Table 2D for Type B agricultural water systems.</li> </ul>
<b>Test Method:</b> Any FDA-allowed method <sup>2</sup>	
<b>Records:</b> Each water sample and analysis shall record the type of water source, date, time, and location of the sample, the method of analysis, and, if quantitative, the detection limit. All test results and remedial actions shall be documented and available for verification from the grower/handler who is the responsible party for a period of two years.	



505 TABLE 2F. Post-Harvest Direct Product Contact or Food-Contact Surfaces

Metric	Rationale /Remedial Actions
<p><b><u>Microbial Testing</u></b>  <b>Target Organism:</b> generic <i>E. coli</i>.  <b>Sampling Procedure:</b>            100 mL sample collected aseptically at the point-of-use.  <b>Sampling Frequency:</b>            One sample per water source shall be collected and tested prior to use if &gt;60 days since last test of the water source. Additional samples shall be collected at intervals of no less than 18 hrs. and at least monthly during use.  <b>Municipal &amp; Well Exemption:</b>            For wells and municipal water sources, if generic <i>E. coli</i> are below detection limits for five consecutive samples, the requirements for 60 days and monthly sampling are waived, and the sampling frequency may be decreased to no less than once every 180 days. This exemption is void if there is a significant water source or distribution system change.  <b>Test Method:</b>            Any FDA allowed method <sup>2</sup>  <b>Acceptance Criteria:</b>            Negative or below DL for all samples</p>	<p>Water that: directly contacts edible portions of harvested crop or is used on food-contact surfaces such as equipment or utensils, shall meet the Maximum Contaminant Level Goal for <i>E. coli</i> as specified by U.S. EPA or contain an approved disinfectant at sufficient concentration to prevent cross-contamination. Microbial or physical/chemical testing shall be performed, as appropriate to the specific operation, to demonstrate that acceptance criteria have been met.</p> <p><b><u>Single Pass vs. Multiple Pass Systems</u></b></p> <ul style="list-style-type: none"> <li>• Single pass use – Water must have non-detectable levels of <i>E. coli</i> or breakpoint disinfectant present at point of entry</li> <li>• Multi-pass use – Water must have non-detectable levels of <i>E. coli</i> and/or sufficient disinfectant to ensure returned water has no detectable <i>E. coli</i> (minimally 1 ppm chlorine).</li> </ul> <p><b><u>Remedial Actions:</u></b>            If any one sample exceeds the acceptance criteria, then the water shall not be used for this purpose or until remedial actions have been completed and generic <i>E. coli</i> or disinfectant levels are within acceptance criteria:</p> <ul style="list-style-type: none"> <li>• Conduct an agricultural water system assessment of water source and distribution system to determine if a contamination source is evident and can be eliminated. Eliminate identified contamination source(s) and/or treat with appropriate disinfectants.</li> <li>• For wells, perform an agricultural water system assessment and/or treat as described in Appendix A.</li> <li>• Retest the water at the same sampling point after conducting the agricultural water system assessment and/or taking remedial actions to determine if it meets the outlined microbial acceptance criteria for this use.</li> </ul>
<p><b><u>Physical/Chemical Testing</u></b>  <b>Target Variable:</b>            Water disinfectant (e.g., chlorine or other disinfectant compound, ORP).  <b>Multi Pass Water Acceptance Criteria:</b>  <u>Chlorine</u>            ≥ 1 ppm free chlorine after application and pH 6.5 – 7.5 <b>OR</b> ORP ≥ 650 mV and pH 6.5 – 7.5  <u>Other approved treatments</u> per product EPA label for human pathogen reduction in water.  <b>Testing Procedure:</b></p> <ul style="list-style-type: none"> <li>• Chemical reaction-based colorimetric test, or</li> <li>• Ion-specific probe, or</li> <li>• ORP, or</li> </ul>	<p>For example, if a water sample for water used to clean food-contact surfaces has detectable <i>E. coli</i>, STOP using that water system, examine the distribution line and source inlet as described in Appendix A and retest from the same point of use. Continue testing daily for five days at the point closest to use, and do not use the water system until it consistently delivers water that is safe, sanitary, and of appropriate microbial quality (i.e., negative result) for the intended use. If any of the five samples taken during the intensive sampling period after corrective actions have been taken have detectable generic <i>E. coli</i>, repeat remedial actions and DO NOT use that system until the source of contamination can be corrected.</p>



- Other as recommended by disinfectant supplier.

**Testing Frequency:**

Continuous monitoring (preferred) with periodic verification by titration **OR** Routine monitoring if the system can be shown to have a low degree of variation.

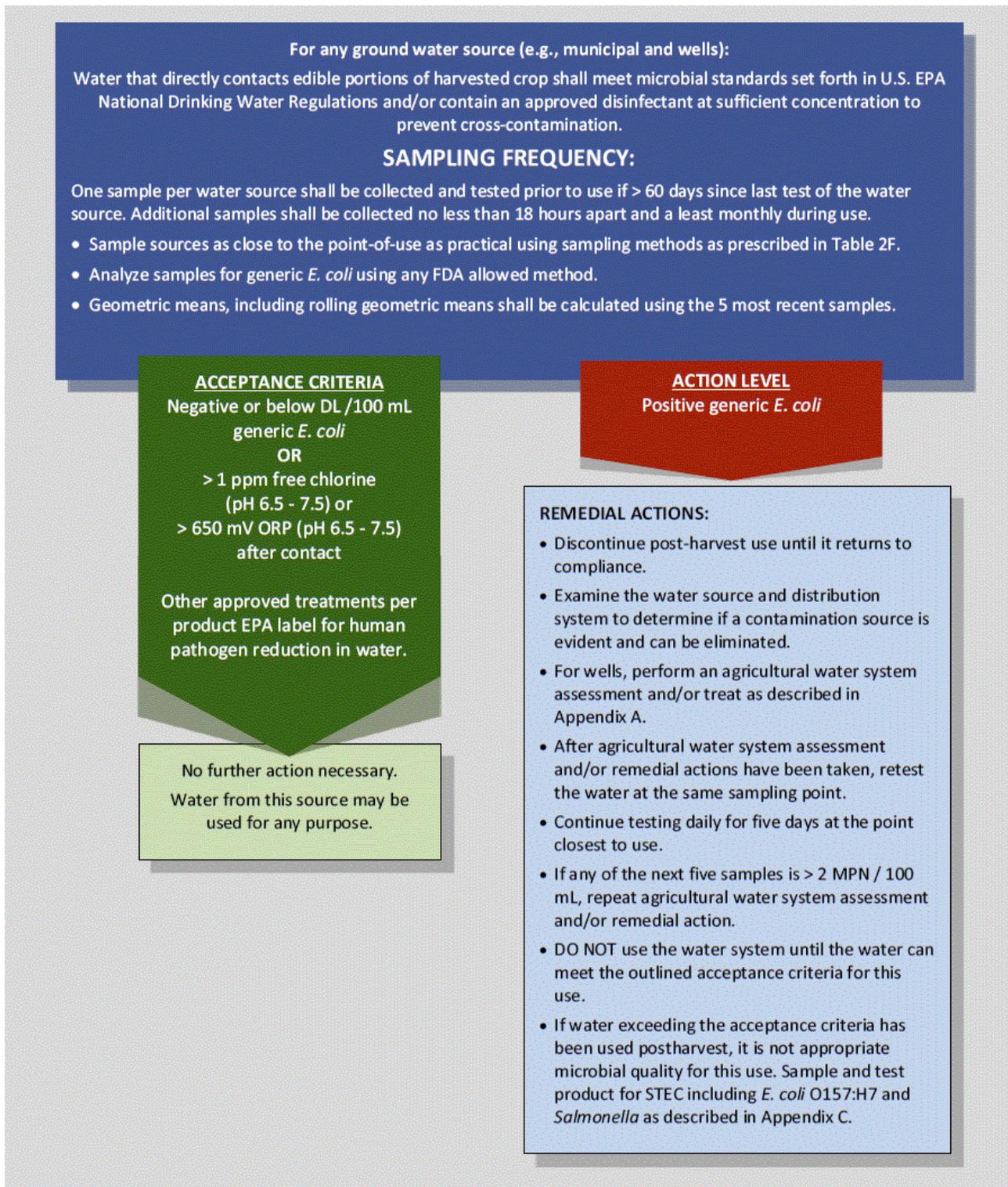
**Records:** All test results and remedial actions shall be documented and available for verification from the user of the water for a period of two years.

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508 FIGURE 5. Post-Harvest Water Use – Direct Product Contact (e.g. re-hydration, core in field, etc.)





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## 7. ISSUE: SOIL AMENDMENTS

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Soil amendments are commonly but not always incorporated prior to planting into agricultural soils used for lettuce/leafy greens production to add organic and inorganic nutrients to the soil as well as intended to improve the physical, chemical, or biological characteristics of soil. Human pathogens may persist in animal manures for weeks or even months (Fukushima et al. 1999; Gagliardi and Karns 2000). Proper composting of animal manures via thermal treatment will reduce the risk of potential human pathogen survival. However, the persistence of many human pathogens in agricultural soils depends on many factors (soil type, relative humidity, UV index, etc.) and the effects of these factors are under extensive investigation (Jiang et al. 2003; Islam et al. 2004).

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### THE BEST PRACTICES ARE:

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- Do not use biosolids as a soil amendment for production of lettuce or leafy greens.
- DO NOT USE raw manure or soil amendments containing untreated animal by-products, un-composted / incompletely composted animal manure and/or green waste, or non-thermally treated animal manure to fields, which will be used for lettuce and leafy green production.
- See Table 3 and Decision Trees (Figures 6A and 6B) for numerical criteria and guidance for compost and soil amendments used in lettuce and leafy greens production fields. The Technical Basis Document (Appendix B) describes the process used to develop these metrics.
- Implement management plans (e.g., timing of applications, storage location, source and quality, transport, etc.) that significantly reduce the likelihood that soil amendments being used contain human pathogens.
- Verify that the time and temperature process used during the composting process reduces, controls, or eliminates the potential for human pathogens being carried in the composted materials, as applicable to regulatory requirements.
- Maximize the time interval between soil amendment application and time to harvest.
- Implement practices that control, reduce or eliminate likely contamination of lettuce/leafy green fields in close proximity to on-farm stacking of manure.
- Use soil amendment application techniques that control, reduce or eliminate likely contamination of surface agricultural water and/or edible crops being grown in adjacent fields.



- 548 • Segregate equipment used for soil amendment handling, preparation, distribution, applications or use  
549 effective means of equipment sanitation before subsequent use that effectively reduce the potential for  
550 cross-contamination.
- 551 • Minimize the proximity of wind-dispersed or aerosolized sources of contamination (e.g., water and manure  
552 piles) that may potentially contact growing lettuce/leafy greens or adjacent edible crops.
- 553 • Compost suppliers and on-farm composting operations shall have written sampling procedures as well as  
554 Standard Operating Procedures to prevent cross-contamination of in-process and finished compost with  
555 raw materials through equipment, runoff, or wind, including instructions for handling, conveying and  
556 storing in-process or finished compost like it is untreated if it becomes contaminated. Growers shall  
557 annually obtain proof that these documents exist.
- 558 • Temperature monitoring and turning records for compost applied to leafy greens crops shall be maintained  
559 for at least two years. Growers purchasing compost shall annually obtain proof from their supplier that this  
560 documentation exists. This applies to composting operations regulated under Title 14 CCR as well as  
561 smaller operations that do not fall under Title 14.
- 562 • Perform microbiological testing of composted soil amendments prior to application (Table 3).
- 563 • Any soil amendment that does not contain animal manure or other animal by-products must have a  
564 document (e.g., ingredient list, statement of identity, letter of guaranty, etc.) from the producer or seller  
565 confirming that the soil amendment is manure / animal by-product-free. This document must indicate in  
566 some way that manure is not an ingredient used in the production of the amendment or provide the  
567 ingredients of the product. A statement of identity or product is sufficient for single-chemical amendments  
568 (i.e., “calcium carbonate” or “gypsum”). If “inert ingredients” are listed as part of an amendment, then a  
569 document from the producer or seller is necessary indicating manure has not been added. The document  
570 confirming the soil amendment is manure-/animal by-product-free must be available for verification  
571 before harvest begins, and it must be saved and available for inspection for 2 years. A new document is  
572 required every two years unless there is a significant process or ingredient change.
- 573 • Retain documentation of all processes and test results by lot (at the supplier) and/or Certificates of  
574 Analysis available for inspection for a period of at least two years.



575 TABLE 3. Soil Amendments

Amendment	Metric/Rationale
<p><b>Raw manure, untreated animal products/by-products, or not fully composted green waste and/or animal manure-containing soil amendments (see composted manure process definition below)</b></p>	<p><b>DO NOT USE OR APPLY</b> soil amendments that contain un-composted, incompletely composted or non-thermally treated (e.g., heated) animal manure <b>or animal product/by-products</b> to fields which will be used for lettuce and leafy greens production. If these materials have been applied to a field, wait one year prior to producing leafy greens.</p>
<p><b>Composted soil amendments (containing animal manure or animal products)</b></p> <p>*Composted soil amendments should not be applied after emergence of plants.</p>	<p><b>Please see Figure 6A: Decision Tree for Use of Composted Soil Amendments.</b></p> <p><b>Composting Process Validation:</b></p> <p><u>Enclosed or within-vessel composting:</u> Active compost must maintain a minimum of 131°F for 3 days</p> <p><u>Windrow composting:</u> Active compost must maintain aerobic conditions for a minimum of 131°F for 15 days or longer, with a minimum of five turnings during this period <b>followed by adequate curing.</b></p> <p><u>Aerated static pile composting:</u> Active compost must be covered with 6 to 12 inches of insulating materials and maintain a minimum of 131°F for 3 days <b>followed by adequate curing.</b></p> <p><b>Target Organisms:</b></p> <ul style="list-style-type: none"> <li>• Fecal coliforms</li> <li>• <i>Salmonella</i> spp.</li> <li>• <i>E. coli</i> O157:H7</li> </ul> <p><b>Acceptance Criteria:</b></p> <ul style="list-style-type: none"> <li>• Fecal coliforms: &lt; 1,000 MPN / gram of total solids (dry weight basis)</li> <li>• <i>Salmonella</i> spp.: Negative or &lt; DL (&lt; 1 MPN / 30 grams)</li> <li>• <i>E. coli</i> O157:H7: Negative or &lt; DL (&lt; 1 MPN / 30 grams)</li> </ul> <p><b>Recommended Test Methods:</b></p> <ul style="list-style-type: none"> <li>• Fecal coliforms: U.S. EPA Method 1680; multiple tube MPN</li> <li>• <i>Salmonella</i> spp.: U.S. EPA Method 1682</li> <li>• <i>E. coli</i> O157:H7: Any laboratory validated method for compost sampling.</li> <li>• Other U.S. EPA, FDA, or AOAC-accredited methods may be used as appropriate.</li> </ul> <p><b>Sampling Plan:</b></p> <ul style="list-style-type: none"> <li>• A composite sample shall be representative and random and obtained as described in the California state regulations.<sup>3</sup> (See Appendix E)</li> <li>• Sample may be taken by the supplier if trained by a testing laboratory or state authority</li> </ul>

<sup>3</sup> CCR Title 14 - Chapter 3.1 - Article 7 - Section 17868.1 <http://www.calrecycle.ca.gov/Laws/Regulations/Title14/ch31a5.htm#article7>



Amendment	Metric/Rationale
	<ul style="list-style-type: none"> <li>Laboratory must be certified/accredited for microbial testing by a <b>certification or accreditation body.</b><sup>4</sup></li> </ul> <p><b>Testing Frequency:</b></p> <ul style="list-style-type: none"> <li>Each lot before application to production fields. A lot is defined as a unit of production equal to or less than 5,000 cubic yards.</li> </ul> <p><b>Application Interval:</b></p> <ul style="list-style-type: none"> <li>Must be applied &gt; 45 days before harvest.</li> </ul> <p><b>Documentation:</b></p> <ul style="list-style-type: none"> <li>All test results and/or Certificates of Analysis shall be documented <b>annually</b> and available for verification from the grower (the responsible party) for a period of two years. <b>Records of process control monitoring for on-farm produced soil amendments must be reviewed, dated, and signed, within a week after the records are made, by a supervisor or responsible party.</b></li> </ul> <p><b>Rationale:</b></p> <ul style="list-style-type: none"> <li>The microbial metrics and validated processes are based on allowable levels from California state regulations for compost (CCR Title 14 - Chapter 3.1 - Article 7), with the addition of testing for <i>E. coli</i> O157:H7 as microbe of particular concern. The 45-day application interval was deemed appropriate due to the specified multiple hurdle risk reduction approach outlined. Raw manure must be composted with an approved process and pass testing requirements before an application.</li> </ul>

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<sup>4</sup> See FDA’s Guidance for Industry: Submission of laboratory packages by accredited laboratories (<https://www.fda.gov/RegulatoryInformation/Guidances/ucm125434.htm>) for information on the process of accreditation.



<p>Soil amendments containing animal manure that has been heat-treated or processed by other equivalent methods.</p>	<p>Please see <b>Figure 6B: Decision Tree for Use of Heat-Treated Soil Amendments.</b></p> <p><b>Heat Process Validation</b></p> <ul style="list-style-type: none"><li>The heat treatment processes applied to the soil amendment-containing animal manure shall be done via a process validated to assure the process is capable of reducing pathogens of human health significance to acceptable levels.</li></ul> <p><b>Target Organism:</b></p> <ul style="list-style-type: none"><li>Fecal coliforms</li><li><i>Salmonella</i> spp.</li><li><i>E. coli</i> O157:H7</li><li><i>Listeria monocytogenes</i></li></ul> <p><b>Acceptance Criteria:</b></p> <ul style="list-style-type: none"><li>Fecal coliforms Negative or &lt;DL per gram</li><li><i>Salmonella</i>: Negative or &lt;DL (&lt;1/30 grams)</li><li><i>E. coli</i> O157:H7 Negative of &lt;DL (&lt;1/30 grams)</li><li><i>Listeria monocytogenes</i>: Not detected or &lt; DL (&lt;1 CFU/5 grams)</li></ul> <p><b>Recommended Test Methods:</b></p> <ul style="list-style-type: none"><li>Fecal coliforms: <b>U.S. EPA Method 1680; multiple tube MPN</b></li><li><i>Salmonella</i> spp.: U.S. EPA Method 1682</li><li><i>E. coli</i> O157:H7 and <i>Listeria monocytogenes</i>: Any laboratory validated method for testing soil amendments</li><li>U.S. EPA, FDA, AOAC-or other accredited methods may be used as appropriate.</li></ul> <p><b>Sampling Plan:</b></p> <ul style="list-style-type: none"><li>Extract at least 12 equivolume samples (identify 12 separate locations from which to collect the sub-sample, in case of bagged product 12 individual bags)</li><li>Sample may be taken by the supplier if trained by a testing laboratory or state authority</li><li>Laboratory must be certified / accredited by annual review of laboratory protocols based on GLPs by a <b>certification or accreditation body.</b></li></ul> <p><b>Testing Frequency:</b></p> <ul style="list-style-type: none"><li>Each lot before application to production fields.</li><li>In lieu of the above analysis requirement, a Certificate of Process Validity issued by a recognized process authority can be substituted. This certificate will attest to the process validity as determined by either a documented (included w/Certificate) inoculated pack study of the standard process or microbial inactivation calculations of organisms of significant risk (included w/Certificate) as outlined in FDA CFSSAN publication “<b>Kinetics of Microbial Inactivation for Alternative Food Processing Technologies. Overarching Principles: Kinetics and Pathogens of Concern for All Technologies</b>” (incorporated for reference in Appendix E - Thermal Process Overview).</li></ul> <p><b>Application Interval:</b></p> <ul style="list-style-type: none"><li>If the heat treatment process used to inactivate human pathogens of significant public health concern that may be found in animal manure containing soil amendments, is</li></ul>
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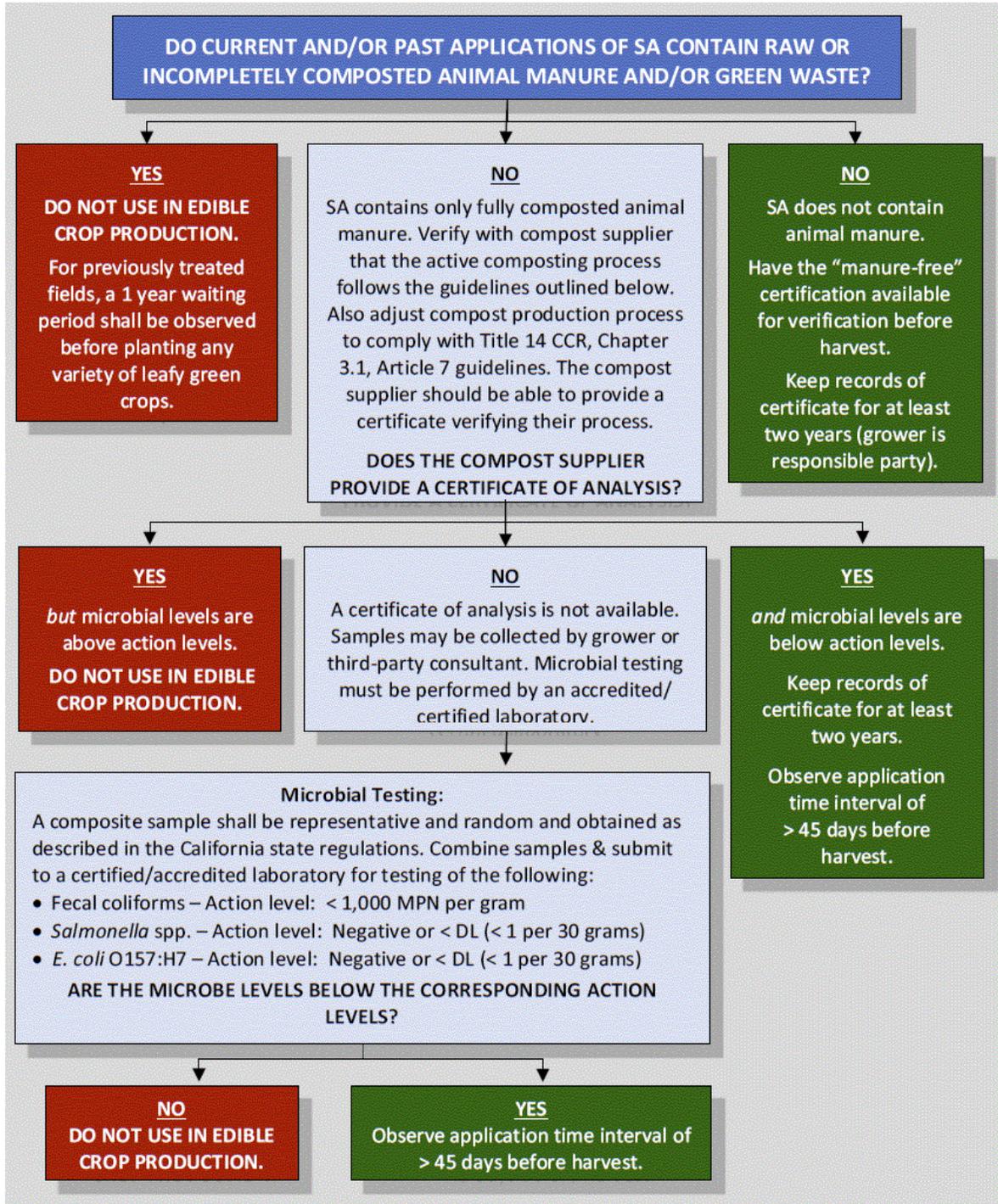


	<p>validated and meets the microbial acceptance criteria outlined above, then no time interval is needed between application and harvest.</p> <ul style="list-style-type: none"> <li>• If the physical heat treatment process used to inactivate human pathogens of significant public health concern that may be found in animal manure containing soil amendments is not validated but will likely significantly reduce microbial populations of human pathogens and meets microbial acceptance criteria outlined above, then a 45-day interval between application and harvest is required.</li> </ul> <p><b>Documentation:</b></p> <ul style="list-style-type: none"> <li>• All test results and/or Certificates of Analysis and/or Certificates of Process Validation shall be documented and available for verification from the grower who is the responsible party for a period of two years. The soil amendment supplier’s operation should be validated by a process authority and a record maintained by the grower for a period of two years.</li> </ul> <p><b>Rationale:</b></p> <ul style="list-style-type: none"> <li>• The microbial metrics are based on allowable levels from California state regulations for compost (CCR Title 14 - Chapter 3.1 - Article 7), with the addition of testing for <i>E. coli</i> O157:H7 as the microbe of particular concern. A more stringent level of fecal coliform was also included to address the much more controlled nature of soil amendments produced in this manner. The above suggested application interval was deemed appropriate due to the specified multiple hurdle risk reduction approach outlined. Raw manure must be composted with an approved process and pass testing requirements before application.</li> <li>• FDA has established the validity of D-values and Z-values for key pathogens of concern in foods. This method of process validation is currently acceptable to US regulators. Alternatively, results of an inoculated test pack utilizing the specific process is also an acceptable validation of the lethality of the process.</li> </ul>
<p><b>Soil Amendments Not Containing Animal Manure</b></p>	<ul style="list-style-type: none"> <li>• Any soil amendment that DOES NOT contain animal manure must have documentation that it is free.</li> <li>• The documentation must be available for verification before harvest begins.</li> <li>• If there is documentation that the amendment does not contain manure or animal products then no additional testing is required, and there is no application interval necessary</li> <li>• Any test results and/or documentation shall be available for verification from the grower who is the responsible party for a period of two years.</li> </ul>



578 FIGURE 6A. Decision Tree for Composted Soil Amendments (SA)

579 If raw manure has been directly applied to the field in the past, a one-year waiting period shall be observed before planting  
580 any variety of leafy green crops.

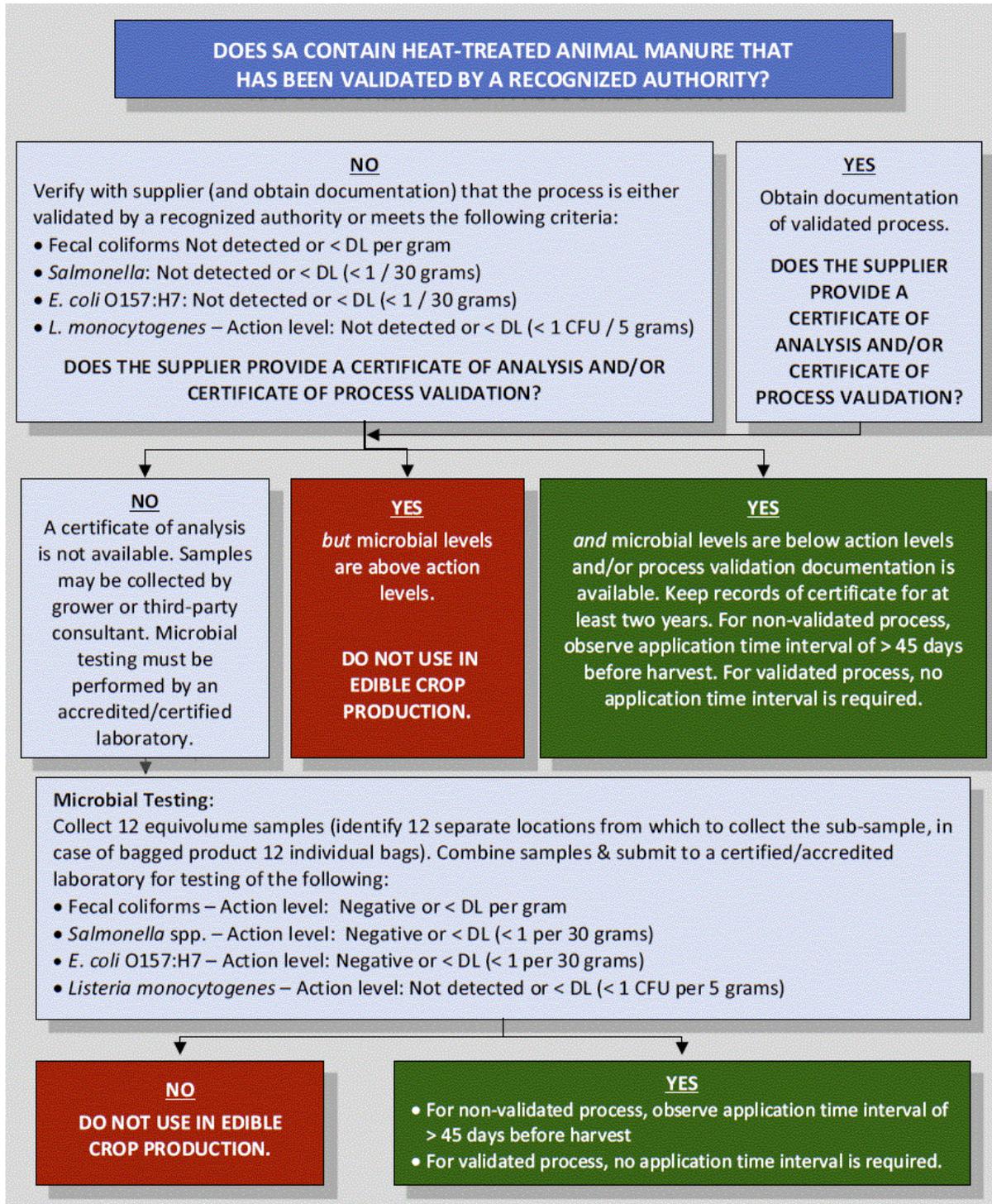


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FIGURE 6b. Decision Tree for Heat-Treated, Animal Manure-Containing Soil Amendments (SA)



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585 **8. ISSUE: NON-SYNTHETIC CROP TREATMENTS**

586 Non-synthetic crop treatments are commonly applied post-emergence for pest and disease control, greening,  
587 and to provide organic and inorganic nutrients to the plant during the growth cycle. For the purposes of this  
588 document, they are defined as any crop input that contains animal manure, an animal product, and/or an  
589 animal by-product that is reasonably likely to contain human pathogens. Due to the potential for human  
590 pathogen contamination, these treatments should only be used under conditions that minimize the risk for  
591 crop contamination.

592 **THE BEST PRACTICES ARE:**

- 593 • Do not use crop treatments that contain raw manure or other untreated animal products or by-products  
594 for lettuce or leafy green produce.
- 595 • Do not apply untreated agricultural or compost teas containing added nutrients (e.g., molasses, yeast  
596 extract, algal powder, etc.) intended to increase microbial biomass directly to lettuce/leafy greens.
- 597 • Water used to make agricultural teas must meet the water quality requirements for post-harvest water  
598 use in Table 1. Liquid crop treatments such as agricultural or compost teas may be used in water  
599 distribution systems provided all other requirements herein are met.
- 600 • Implement management plans (e.g. timing of applications, storage location, source and quality, transport,  
601 etc.) that assure to the greatest degree practicable that the use of crop treatments does not pose a  
602 significant pathogen contamination hazard.
- 603 • Verify that the time and temperature process used during crop treatment manufacture reduces, controls,  
604 or eliminates the potential for human pathogens being carried in the non-synthetic crop treatment  
605 materials, as applicable to regulatory requirements.
- 606 • Maximize the time interval between the crop treatment application and time to harvest.
- 607 • Implement practices that control, reduce or eliminate likely contamination of lettuce/leafy green fields  
608 that may be in close proximity to on-farm storage of crop treatments (see Table 7 for additional metrics).
- 609 • Use crop treatment application techniques that control, reduce or eliminate the likely contamination of  
610 surface water and/or edible crops being grown in adjacent fields.
- 611 • Segregate equipment used for crop treatment applications or use effective means of equipment  
612 sanitation before subsequent use.
- 613 • See Table 4 and Decision Tree (Figure 7) for numerical criteria and guidance for non-synthetic crop  
614 treatments used in lettuce and leafy greens production fields. The *Technical Basis Document* (Appendix B)  
615 describes the process used to develop these metrics.
- 616 • Retain documentation of all test results available for inspection for a period of at least two years.



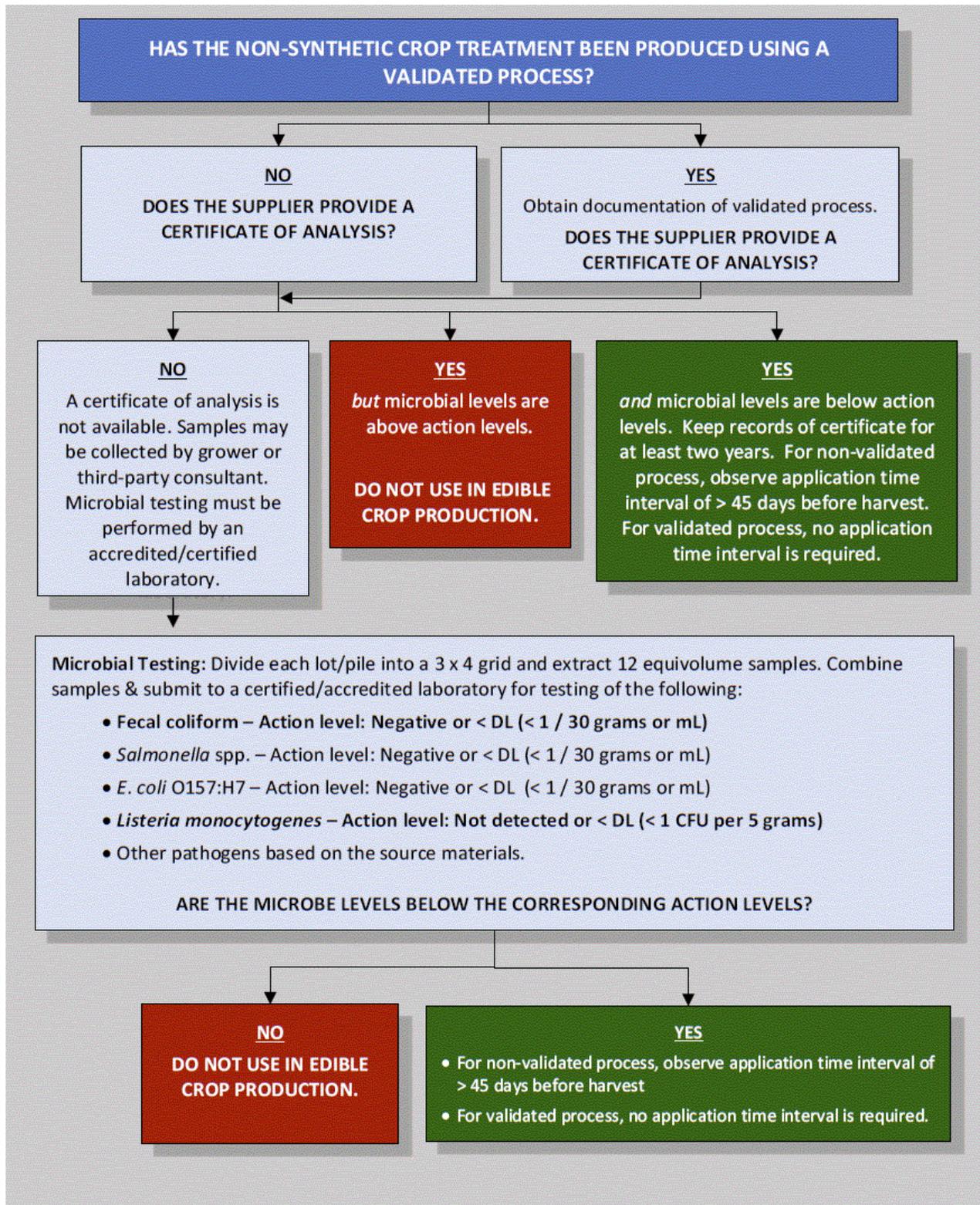
617 TABLE 4. Non-synthetic Crop Treatments

Treatment	Metric/Rationale
<p><b><i>Any crop input that contains animal manure, an animal product, and/or an animal by-product that is reasonably likely to contain human pathogens.</i></b></p> <p>Examples include but are not limited to:</p> <ul style="list-style-type: none"> <li>• <b>Agricultural /</b> Compost teas,</li> <li>• Fish emulsions</li> <li>• Fish meal</li> <li>• Blood meal</li> <li>• "Bio-fertilizers" commonly used for pest control, greening, disease control, fertilizing.</li> </ul> <p>Suppliers of these products shall disclose on labels, certificates of analysis, or other companion paperwork whether the product contains any animal manure or products.</p>	<p><b>Non-synthetic crop treatments that contain animal products or animal manure that have not been heat-treated or processed by other equivalent methods shall NOT be directly applied to the edible portions of lettuce and leafy greens.</b></p> <p><b>Please see Figure 7: Decision Tree for Use of Non-Synthetic Crop Treatments.</b></p> <p><b>Process Validation</b></p> <ul style="list-style-type: none"> <li>• The physical, chemical and/or biological treatment process(es) used to render the crop input safe for application to edible crops must be validated.</li> </ul> <p><b>Target Organism:</b></p> <ul style="list-style-type: none"> <li>• <b>Fecal coliform</b></li> <li>• <i>Salmonella</i> spp.</li> <li>• <i>E. coli</i> O157:H7</li> <li>• <b>Listeria monocytogenes</b></li> <li>• Other pathogens appropriate for the source material</li> </ul> <p><b>Acceptance Criteria (at point of use):</b></p> <ul style="list-style-type: none"> <li>• <b>Fecal coliform: Negative or &lt;DL (&lt; 1 / 30 grams or mL)</b></li> <li>• <i>Salmonella</i> spp.: Negative or &lt; DL (&lt; 1 / 30 grams or mL)</li> <li>• <i>E. coli</i> O157:H7: Negative or &lt; DL (&lt; 1 / 30 grams or mL)</li> <li>• <b>Listeria monocytogenes: Not detected or &lt; DL (&lt; 1 CFU / 5 grams or mL)</b></li> </ul> <p><b>Recommended Test Methods:</b></p> <ul style="list-style-type: none"> <li>• <b>Fecal coliform: U.S. EPA Method 1680; Multiple tube MPN</b></li> <li>• <i>Salmonella</i> spp.: U.S. EPA Method 1682</li> <li>• <i>E. coli</i> O157:H7 and <b>Listeria monocytogenes</b>: Any laboratory validated method for the non-synthetic material to be tested.</li> <li>• Other U.S. EPA, FDA, or AOAC-accredited methods may be used as appropriate</li> </ul> <p><b>Sampling Plan:</b></p>



Treatment	Metric/Rationale
	<ul style="list-style-type: none"> <li>• If solid, 12-point sampling plan composite sample, or if liquid, one sample per batch (if liquid-based, then water quality acceptance levels as described in Table 1 must be used).</li> <li>• Sample may be taken by the supplier if trained by the testing laboratory</li> </ul> <p><b>Application Interval:</b></p> <ul style="list-style-type: none"> <li>• If the physical, chemical and/or biological treatment process used to render the crop input safe for application to edible crops is validated and meets that microbial acceptance criteria outlined above, no time interval is needed between application and harvest.</li> <li>• If the physical, chemical and/or biological treatment process used to render the crop input safe for application to edible crops is not validated yet meets the microbial acceptance criteria outlined above, a 45-day time interval between application and harvest is required.</li> </ul> <p><b>Documentation:</b></p> <ul style="list-style-type: none"> <li>• All test results and/or Certificates of Analysis shall be documented and available from the grower for verification for a period of 2 years. The grower is the responsible party for maintaining the appropriate records.</li> </ul> <p><b>Rationale:</b></p> <p>The microbial metrics and validated processes are based on allowable levels from California state regulations for compost (CCR Title 14 - Chapter 3.1 - Article 7), with the addition of testing for <i>E. coli</i> O157:H7 as the microbe of particular concern. The above suggested application interval was deemed appropriate due to the specified multiple hurdle risk reduction approach outlined. Any non-synthetic crop treatment that contains animal manure must use only fully composted manure in addition to a validated process and pass testing requirements before a application to soils or directly to edible portions of lettuce and leafy greens.</p>

619 FIGURE 7. Decision Tree for Non-Synthetic Crop Treatments That Contain Animal Products





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**NOTE: MIXTURES OF SOIL AMENDMENT MATERIALS**

For soil amendments that contain mixtures of materials, each component must meet the requirements of its respective class of materials. The usages allowed will conform to that of the most stringent class of materials utilized in the mixture.

For example, soil amendments containing animal manure that has been heat-treated or processed by other equivalent methods that are mixed with soil amendments not containing animal manure would require a process certification for the heat-treated (or processed by other equivalent methods) materials and the components from non-animal manure would require documentation attesting to its manure-free status. The resulting mixture could then be applied in accordance with the guidelines associated with the heated treated class of materials (most stringent limits).

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## 9. ISSUE: HARVEST EQUIPMENT, PACKAGING MATERIALS, AND BUILDINGS (FIELD SANITATION)

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This section addresses harvest and harvest aid equipment and packaging materials used for lettuce/leafy greens as well as any fully- or partially-enclosed buildings used to store food-contact surfaces and packaging materials.

Mechanical or machine harvest has become increasingly prevalent and provides opportunity for increased surface contact exposure. This includes field-cored lettuce operations that use various harvest equipment and aids.

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### THE BEST PRACTICES ARE:

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- Use equipment such as pallets, forklifts, tractors, and vehicles that may have contact with leafy greens in a manner that minimizes the potential for product or food contact surface contamination.
- Clean and sanitize food contact surfaces on harvest equipment at the end of each daily harvest.
- Based on inspection, if necessary, rinse and sanitize food contact surfaces on harvest equipment prior to beginning daily harvest.
- All water utilized in cleaning and sanitizing of equipment must meet Postharvest water acceptance criteria.
- Prepare an SOP for harvest equipment and containers that addresses the following:
  - Clean and sanitize when moving between commodities and fields
  - Daily inspection, cleaning and sanitation
  - Proper cleaning, sanitation and storage of hand-harvest equipment (knives, scythes, etc.)
  - Sanitation verification
  - Control procedures when equipment is not in use, including policy for removal of equipment from the work area or site and the use of scabbards, sheathes or other storage equipment.
- Prepare an SOP for handling and storage of harvest containers that addresses the following:
  - Overnight storage
  - Contact with the ground
  - Container assembly (RPC, fiber bin, plastic bin, etc.)



- 659 ○ Damaged containers
- 660 ○ Use of containers only as intended
- 661 ● Prepare an SOP for sanitary operation of equipment which addresses the following:
  - 662 ○ Spills and leaks
  - 663 ○ Inoperative water sprays
  - 664 ○ Exclusion of foreign objects (including glass, plastic, metal and other debris)
  - 665 ○ Establish and implement maintenance, cleaning, and sanitation schedules for containers and
  - 666 equipment used in hydration.
  - 667 ○ Establish and implement procedures for the storage and control of water tanks and equipment used
  - 668 for hydration when not in use.
  - 669 ○ Maintain logs documenting cleaning and sanitation, and retain these records for at least two years.
- 670 ● Establish and implement appropriate measures that reduce and control the potential introduction of
- 671 human pathogens at the cut surface during and after mechanical harvest operations. Due to the cut surface
- 672 being more vulnerable to microbial contamination, this best practice is extremely important. Take all practical
- 673 means to reduce the possibility of introduction of contamination at this process step.
- 674 ● If re-circulated rinse or antioxidant solutions are used on the cut surface, take all practicable precautions
- 675 to prevent them from becoming a source of contamination.
- 676 ● Instruments or controls used to measure, regulate, or record temperatures, hydrogen ion concentration
- 677 (pH), sanitizer efficacy, or other conditions must be:
  - 678 ○ Accurate and precise as necessary and appropriate for their intended use
  - 679 ○ Adequately maintained; and
  - 680 ○ Adequate in number for their designated uses.
- 681 ● Convey, store, and dispose of trash, litter, and waste to:
  - 682 ○ Minimize the potential to attract and harbor pests.
  - 683 ○ Protect lettuce/leafy greens, food-contact surfaces, production areas, and agricultural water sources
  - 684 and distribution systems from contamination.
- 685 ● Design equipment and tools to facilitate cleaning by using materials and construction that facilitate
- 686 cleaning of non-food contact surfaces and cleaning and sanitation of food-contact surfaces (e.g.,
- 687 transportation tarps, conveyor belts, etc.).
  - 688 ○ Seams on food-contact surfaces on equipment and tools must be smoothly bonded or maintained to
  - 689 minimize accumulation of dirt, filth, food particles, and organic materials and the opportunity for
  - 690 harborage or growth of microorganisms.
- 691 ● Establish policies and implement sanitary design principles that facilitate frequent and thorough cleaning
- 692 of non-food-contact surfaces and cleaning and sanitizing of food-contact surfaces.
  - 693 ○ Establish sanitation and/or cleaning frequency of food-contact and non-food contact surfaces of
  - 694 equipment, tools, and containers by developing and implementing Sanitation Standard Operating
  - 695 Procedures (SSOPs) and a sanitation schedule for machine harvest operations.
  - 696 ○ Evaluate the use of cleaning verification methods for harvesting equipment (e.g., ATP test methods).



- 697 ○ Document the date and method of cleaning and sanitizing. A supervisor or responsible party must  
698 review, date, and sign these records within a week after the records are made.
- 699 ● Develop and implement appropriate cleaning, sanitizing, storage, and handling procedures of all  
700 equipment and food-contact surfaces to reduce and control the potential for microbial cross-contamination.
- 701 ○ Locate equipment, tool, and container cleaning and sanitizing operations away from product and  
702 other equipment to reduce the potential for cross-contamination.
- 703 ○ If equipment and tool food-contact surfaces have contact with produce that is not covered by the  
704 Produce Safety Rule, adequately clean and sanitize before using this equipment to harvest  
705 lettuce/leafy greens.
- 706 ● Use packaging materials that are cleanable or designed for single-use and unlikely to support the growth  
707 or transfer of bacteria.
- 708 ● If packaging materials are reused, take steps to ensure food-contact surfaces are clean or covered with a  
709 clean liner.
- 710 ● Establish and implement equipment and tool storage and control procedures to minimize the potential  
711 for contamination and to prevent it from attracting and harboring pests when not in use.
- 712 ● Allow adequate distance for the turning and manipulation of harvest equipment to prevent cross-  
713 contamination from areas or adjacent land that may pose a risk.
- 714 ● Buildings must be suitable in size, construction and design to facilitate building maintenance and sanitary  
715 operations to reduce the potential for contamination of food contact surfaces with known or reasonably  
716 foreseeable hazards. Buildings must:
  - 717 ○ Provide sufficient space for placement of equipment and storage of packaging materials.
  - 718 ○ Take proper precautions to reduce potential for contamination of food contact surfaces or packaging  
719 materials. Reduce the potential for contamination by effective building design including the  
720 separations of operations in which contamination is likely to occur by location, time, partition,  
721 enclosed systems, or other effective means.
  - 722 ○ Provide adequate drainage in all areas where water or other liquid waste is discharged on the ground  
723 or floor of the building.
  - 724 ○ Prevent contamination of food-contact surfaces and packaging materials by protecting them from  
725 drips or condensate and excluding pests and animals.

## 726 10. ISSUE: HARVEST PERSONNEL - DIRECT CONTACT WITH SOIL AND CONTAMINANTS 727 DURING HARVEST (FIELD SANITATION)

728 After manual harvest of lettuce/leafy greens, placing or stacking product on soil before the product is placed  
729 into a container may expose the product to human pathogens if the soil is contaminated. Research has  
730 demonstrated that microbes, including human pathogens, can readily attach to cut lettuce/leafy green  
731 surfaces (Takeuchi et al. 2001).

### 732 THE BEST PRACTICES ARE:

- 733 ● Evaluate appropriate measures that reduce and control the potential introduction of human pathogens  
734 through soil contact at the leafy green cut surface after harvest (e.g. frequency of knife sanitation, no



735 placement of cut surfaces of harvested product on the soil, container sanitation, single-use container lining,  
736 etc.).

- 737 • Discard and do not pack any lettuce/leafy greens dropped on the ground during harvest.
- 738 • Do not stack soiled bins on top of each other if the bottom of one bin has had direct contact with soil  
739 unless a protective barrier (i.e., liner, cover, etc.) is used to separate the containers.
- 740 • Establish and implement a SOP for handling in-field trash and other debris including transporting it out of  
741 the field in a manner that does not pose a contamination risk.

## 742 11. ISSUE: FIELD AND HARVEST PERSONNEL - TRANSFER OF HUMAN PATHOGENS BY 743 WORKERS (FIELD SANITATION)

744 It is possible for persons in the field to transfer microorganisms of significant public health concern to produce  
745 during pre-harvest and harvest activities. Establish and implement preventive measures to minimize potential  
746 contamination of leafy greens especially during harvest activities when each lettuce/leafy greens plant is  
747 touched/handled by harvest crews.

### 748 THE BEST PRACTICES ARE:

- 749 • Use appropriate preventive measures outlined in GAPs such as training in effective hand-washing, glove  
750 use and replacement, and mandatory use of sanitary facilities to reduce and control potential contamination.
- 751 • Establish and implement a written worker practices program (i.e., an SOP) for verifying employee  
752 compliance with company food safety policies. This program shall establish the following practices for field  
753 and harvest employees as well as visitors.
  - 754 ○ During growing and harvesting operations, there must be at least one individual designated as  
755 responsible for food safety in compliance with these best practices.
  - 756 ○ Use, storage, recordkeeping, and proper labeling of chemicals.
  - 757 ○ Follow and be trained in proper hygiene practices and policies including:
    - 758 ▪ Requirements for workers to wash their hands with soap and running water before beginning or  
759 returning to work, before putting on gloves, after using the toilet, as soon as practical after  
760 touching animals or any waste of animal origin, and at any other time when hands may have  
761 become contaminated.
    - 762 ▪ Requirement for workers' clothing to be clean at the start of the day and appropriate for the  
763 operation.
    - 764 ▪ If gloves are used in handling or harvesting lettuce/leafy greens, maintain gloves in an intact and  
765 sanitary condition and replace them when no longer able to do so. Avoiding contact with any  
766 animals.
    - 767 ▪ Confinement of smoking, eating, and drinking of beverages other than water to designated areas.
    - 768 ▪ Prohibitions on spitting, urinating, or defecating in the field.
  - 769 ○ Make visitors aware of policies and procedures to protect lettuce/leafy greens and food contact  
770 surfaces from contamination by people and take all steps reasonably necessary to ensure that  
771 visitors comply with such policies and procedures.



- 772 • Develop and implement a written physical hazard prevention program for leafy green products that are  
773 intended for further processing. The program must address the following:
  - 774 ○ Employee clothing and jewelry (head and hair restraints, aprons, gloves, visible jewelry, etc.).  
775 Removing or covering hand jewelry (if allowed) that cannot be adequately cleaned and sanitized  
776 during periods in which leafy greens are manipulated by hand.
  - 777 ○ Removal of all objects from upper pockets.
  - 778 ○ Designated storage for personal items.
- 779 • Establish and implement a worker health practices program (i.e., an SOP) addressing the following issues:
  - 780 ○ Workers with diarrheal disease or symptoms of other infectious disease are prohibited from being  
781 in the field and handling fresh produce and food contact surfaces.
  - 782 ○ Workers with open cuts or lesions are prohibited from handling fresh produce and food contact  
783 surfaces without specific measures to prevent cross-contamination.
  - 784 ○ Actions for employee to take in the event of injury or illness i.e., notifying a supervisor or other  
785 responsible party.
  - 786 ○ A policy describing procedures for handling/disposition of produce or food-contact surfaces that  
787 have come into contact with blood or other body fluids.
- 788 • A field sanitary facility program (i.e., an SOP) shall be implemented, and it should address the following  
789 issues: the number, condition, and placement of field sanitation units according to federal, state or local  
790 regulation, the accessibility of the units to the work area, facility maintenance, facility supplies [i.e., hand  
791 soap, water (use of antiseptic/sanitizer or wipes, as a substitute for soap and water, is not permitted), single-  
792 use paper towels, toilet paper, etc.], facility signage, facility cleaning and servicing, and a response plan for  
793 major leaks or spills.
  - 794 ○ During harvest, packing, and holding activities, hand-washing facilities must be furnished with  
795 microbial potable running water.
  - 796 ○ Sanitary facilities should be placed such that the location minimizes the impact from potential  
797 leaks and/or spills while allowing access for cleaning and service.
  - 798 ○ The location and sanitary design of sanitary facilities should be optimized to facilitate the control,  
799 reduction, and elimination of human pathogens from employee hands. Evaluate the location of  
800 sanitary facilities to maximize employee/visitor accessibility and use, while minimizing the  
801 potential for the facility to serve as a source of contamination.
  - 802 ○ Establish and implement the frequency of sanitary facilities maintenance/sanitation and the  
803 appropriate disposal of waste.
  - 804 ○ Establish and implement equipment and supply storage and control procedures when not in use.
  - 805 ○ Maintain documentation of maintenance and sanitation schedules and any remedial practices for  
806 a period of two years.

## 12. ISSUE: EQUIPMENT FACILITATED CROSS-CONTAMINATION (FIELD SANITATION)

When farm equipment has had direct contact with raw untreated manure, untreated compost, waters of unknown quality, animals or other potential human pathogen reservoirs it may be a source of cross-



810 contamination. Such equipment should not be used in proximity to or in areas where it may contact edible  
811 portions of lettuce and or leafy greens without proper sanitation.

## 812 THE BEST PRACTICES ARE:

- 813 • Identify any field operations that may pose a risk for cross-contamination. These include management  
814 personnel in the fields, vehicles used to transport workers, as well as many other possibilities.
- 815 • Segregate equipment and tools used in high-risk operations or potentially exposed to high levels of  
816 contamination.
- 817 • If equipment was previously used in a high-risk operation, use effective means of cleaning and sanitation  
818 before subsequent equipment use in lettuce/leafy greens production.
- 819 • Develop and implement appropriate means of reducing and controlling the possible transfer of human  
820 pathogens to soil and water that may directly contact edible lettuce/leafy green tissues through use of  
821 equipment.
- 822 • Maintain appropriate records related to equipment cleaning and possible cross-contamination issues for a  
823 period of two years.

## 824 13. ISSUE: FLOODING

825 Flooding for purposes of this document is defined as the flowing or overflowing of a field with water outside of  
826 a grower's control, that is reasonably likely to contain microorganisms of significant public health concern and  
827 is reasonably likely to cause adulteration of the edible portions of fresh produce in that field. Pooled water (e.g., rainfall) that is not  
828 reasonably likely to contain microorganisms of significant public health concern and is not reasonably likely to  
829 cause adulteration of the edible portion of fresh produce should not be considered flooding.

830 If flood waters contain microorganisms of significant public health concern, crops in close proximity to soil  
831 such as lettuce/leafy greens may be contaminated if there is direct contact between flood water or  
832 contaminated soil and the edible portions of lettuce/leafy greens (Wachtel et al. 2002a; 2002b).

833 In the November 4, 2005 FDA "Letter to California Firms that Grow, Pack, Process, or Ship Fresh and Fresh-cut  
834 Lettuce/leafy greens" the agency stated that it "considers ready-to-eat crops (such as lettuce/leafy greens)  
835 that have been in contact with flood waters to be adulterated due to potential exposure to sewage, animal  
836 waste, heavy metals, pathogenic microorganisms, or other contaminants. FDA is not aware of any method of  
837 reconditioning these crops that will provide a reasonable assurance of safety for human food use or otherwise  
838 bring them into compliance with the law. Therefore, FDA recommends that such crops be excluded from the  
839 human food supply and disposed of in a manner that ensures they do not contaminate unaffected crops  
840 during harvesting, storage or distribution.

841 "Adulterated food may be subject to seizure under the Federal Food, Drug, and Cosmetic Act, and those  
842 responsible for its introduction or delivery for introduction into interstate commerce may be enjoined from  
843 continuing to do so or prosecuted for having done so. Food produced under unsanitary conditions whereby it  
844 may be rendered injurious to health is adulterated under § 402(a)(4) of the Federal Food, Drug, and Cosmetic  
845 Act (21 U.S.C. 342(a) (4); (US FDA 2004).

846 Areas that have been flooded can be separated into three groups: 1) product that has come into contact with  
847 flood water, 2) product that is in proximity to a flooded field but has not been contacted by flood water, and  
848 3) production ground that was partially or completely flooded in the past before a crop was planted. The  
849 considerations for each situation are described below and presented in Table 5.



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THE BEST PRACTICES FOR PRODUCT THAT HAS COME INTO CONTACT WITH FLOOD WATER ARE:

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- See Table 5 for numerical criteria for lettuce and leafy greens production fields that have possibly come into contact with flood waters. The Technical Basis Document (Appendix B) describes the process used to develop these metrics.

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- FDA considers any crop that has come into contact with floodwater to be an “adulterated” commodity that cannot be sold for human consumption.

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- To reduce the potential for cross-contamination do not drive harvest equipment through flooded areas reasonably likely to contain microorganisms of public health significance (see previous section).

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858 TABLE 5. Flooding - When Evidence of Flooding In A Production Block Occurs.

Practice	Metric/Rationale
<b>Flooding Defined</b>	The flowing or overflowing of a field with water outside a grower’s control that is reasonably likely to contain microorganisms of significant public health concern and is reasonably likely to cause adulteration of edible portions of fresh produce in that field. Additional discussion of this definition and implications for production is provided in the text portion of this document.
<b>Allowable Harvest Distance from Flooding</b>	<ul style="list-style-type: none"> <li>• Buffer and do not harvest any product within 30 ft. of the flooding.</li> <li>• Required buffer distance may be greater than 30 ft. based on risk analysis by food safety professional.</li> <li>• If there is evidence of flooding, the production block must undergo a detailed food safety assessment by appropriately trained food safety personnel (see Glossary) prior to harvest, as defined in the text of this document.</li> </ul>
<b>Verification</b>	<ul style="list-style-type: none"> <li>• Documentation must be archived for a period of two years following the flooding event. Documentation may include photographs, sketched maps, or other means of delineating affected portions of production fields.</li> </ul>
<b>Time Interval Before Planting Can Commence Following the Receding of Floodwaters</b>	<ul style="list-style-type: none"> <li>• 60 days prior to planting provided that the soil has sufficient time to dry out.</li> <li>• Appropriate soil testing can be used to shorten this period to 30 days prior to planting. This testing must be performed in a manner that accurately represents the production field and indicates soil levels of microorganisms lower than the recommended standards for processed compost. Suitable representative samples should be collected for the entire area suspected to have been exposed to flooding. For additional guidance on appropriate soil sampling techniques, use the Soil Screening Guidance: Technical Background Document (US EPA 1996). Specifically, Part 4 provides guidance for site investigations. Reputable third-party environmental consultants or laboratories provide sampling services consistent with this guidance.</li> <li>• Appropriate mitigation and mitigation strategies are included in the text portion of the document.</li> </ul>
<b>Rationale</b>	<ul style="list-style-type: none"> <li>• The basis for the 30 ft. distance is the turn around distance for production equipment to prevent cross-contamination of non-flooded ground or produce.</li> </ul>



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### THE BEST PRACTICES FOR PRODUCT IN PROXIMITY TO A FLOODED AREA, BUT NOT CONTACTED BY FLOOD WATER ARE:

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- Prevent cross-contamination between flooded and non-flooded areas (e.g. cleaning equipment, eliminating contact of any farming or harvesting equipment or personnel with the flooded area during growth and harvest of non-flooded areas).

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- To facilitate avoiding contaminated/adulterated produce, place markers identifying both the high-water line of the flooding and an interval 30 feet beyond this line. If 30 feet is not sufficient to prevent cross-contamination while turning harvesting or other farm equipment in the field, use a greater appropriate interval. Take photographs of the area for documentation. Do not harvest product within the 30-foot buffer zone.

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### THE BEST PRACTICES FOR FORMERLY FLOODED PRODUCTION GROUND ARE:

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- Prior to replanting or soil testing, the designated food safety professional for the grower shall perform a detailed food safety assessment of the production field. This designated professional will be responsible for assessing the relative merits of testing versus observing the appropriate time interval for planting, and also will coordinate any soil testing plan with appropriate third-party consultants and/or laboratories that have experience in this type of testing.

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- Evaluate the source of flood waters (e.g., drainage canal, river, irrigation canal, etc.) for potential significant upstream contributors of human pathogens at levels that pose a significant threat to human health.

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- Allow soils to dry sufficiently and be reworked prior to planting subsequent crops on formerly flooded production ground.

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- Do not replant formerly flooded production ground for at least 60 days following the receding of floodwaters. This period or longer and active tillage of the soil provide additional protection against the survival of pathogenic organisms.

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- If flooding has occurred in the past on the property, soil clearance testing may be conducted prior to planting leafy greens. Soil testing may be used to shorten the clearance period to 30 days. If performed, testing must indicate soil levels of microorganisms lower than the standards for processed compost. Suitable representative samples should be collected for the entire area suspected to have been exposed to flooding.

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- Sample previously flooded soil for the presence of microorganisms of significant public health concern or appropriate indicator microorganisms. Microbial soil sampling can provide valuable information regarding relative risks; however, sampling by itself does not guarantee that crops grown within the formerly flooded production area will be free of the presence of human pathogens.

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- Evaluate the field history and crop selection on formerly flooded production ground.

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- Assess the time interval between the flooding event, crop planting, and crop harvest. Comparative soil samples may be utilized to assess relative risk if significant reductions in indicator microorganisms have occurred within this time interval.

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- 897
- Prevent cross-contamination by cleaning or sanitizing any equipment that may have contacted previously
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## 14. ISSUE: PRODUCTION LOCATIONS - CLIMATIC CONDITIONS AND ENVIRONMENT

899

900 Lettuce/leafy greens are grown in varying regions but generally in moderate weather conditions. Cool, humid

901 conditions favor human pathogen persistence (Takeuchi and Frank 2000; Takeuchi et al. 2000) while drier

902 climates may present other problems such as requirements for additional water that may increase the

903 potential for introduction of human pathogens. Heavy rains in certain areas may also cause lettuce/leafy

904 greens to be exposed to contaminated soil due to rain splashing. It is important to tailor practices and

905 procedures designed to promote food safety to the unique environment in which each crop may be produced.

### THE BEST PRACTICES ARE:

- 906
- Consider harvest practices such as removing soiled leaves, not harvesting soiled heads, etc., when excessive
- 907
- 908 soil or mud builds up on lettuce/leafy greens.

909 The Best Practices for Environmental Source of Pathogens and Conditions and Environments:

- Take care to reduce the potential for windborne soil, including soil from roads adjacent to fields, water, or other media that may be a source of contamination to come into direct contact with the edible portions of lettuce and leafy greens. Do not allow runoff from adjacent properties to come into contact with produce.
  - Evaluate and implement practices to reduce the potential for the introduction of pathogens into production blocks by wind or runoff. Such practices may include but are not limited to berms, windbreaks, diversions, ditches and vegetated filter strips.
  - Establish an SOP for production locations that have environmental source of pathogens (i.e. CAFO, dairy, hobby farm and manure or livestock compost facility) and the potential for contamination during weather conditions and events.
  - When soil has accumulated on plants, remove soil during the harvest or further processing.
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## 15. ISSUE: PRODUCTION LOCATIONS - ENCROACHMENT BY ANIMALS AND URBAN

### SETTINGS

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923 Lettuce/leafy greens are generally grown in rural areas that may have adjacent wetlands, wildlands, parks

924 and/or other areas where animals may be present. Some animal species are known to be potential carriers of

925 various human pathogens (Fenlon 1985; Gorski et al. 2011; Jay et al. 2007; Keene et al. 1997; Lejeune et al.

926 2008; Perz et al. 2001). In addition, extensive development in certain farming communities has also created

927 situations with urban encroachment and unintentional access by domestic animals and/or livestock which

928 may also pose varying degrees of risk. Finally, it is possible that some land uses may be of greater concern

929 than others when located near production fields. Table 7 provides a list of these uses and recommended

930 buffer distances.

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## THE BEST PRACTICES ARE:

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- See Tables 6 and 7 and Decision Tree (Figure 8) for numerical criteria and guidance applicable to animal encroachment and adjacent land uses. The Technical Basis Document (Appendix B) describes the process used to develop these metrics.
- During the Environmental Assessments discussed in Section 3, the location of any adjacent land uses that are likely to present a food safety risk should be documented. In addition, as specified in Table 7, any deviations from the recommended buffer distances due to mitigation factors or increased risk should be documented.
- Evaluate and monitor animal activity in and proximate to lettuce/leafy greens fields and production environments. Conduct and document periodic monitoring and pre-season, pre-harvest, and harvest assessments. If animals present a probable risk (medium/high hazard), make particular efforts to reduce their access to lettuce and leafy green produce.
- Fencing, vegetation removal, and destruction of habitat may result in adverse impacts to the environment. Potential adverse impacts include loss of habitat to beneficial insects and pollinators; wildlife loss; increased discharges of sediment and other pollutants resulting from the loss of vegetative filtering; and increased air quality impacts if bare soil is exposed to wind. It is recommended that producers check for local, state, and federal laws and regulations that protect riparian habitat and wetland areas, restrict removal of vegetation or habitat, or regulate wildlife deterrence measures, including hazing, harassment, lethal and non-lethal removal, etc.
- Evaluate the risk to subsequent crop production or production acreage that has experienced recent postharvest grazing with or by domesticated animals that used field culls as a source of animal feed.
- Document any probable risk (medium/high hazard) during production and/or harvest periods and take appropriate corrective action per Table 7 in LGMA metrics.
- Locate production blocks to minimize potential access by animals and maximize distances to possible sources of microbial contamination. For example, consider the proximity to water (i.e., riparian areas), animal harborage, open range lands, non-contiguous blocks, urban centers, etc. Periodically monitor these factors and assess during pre-season and pre-harvest assessments as outlined in Tables 6 and 7. If the designated food safety professional deems that there is the potential for microbial contamination from adjacent areas, a risk assessment shall be performed to determine the risk level as well as to evaluate potential strategies to control or reduce the introduction of human pathogens.
- DO NOT harvest areas of fields where unusually heavy activity by animals has occurred (see Figure 8 Decision Tree).
- If animal intrusions are common on a particular production field, consider fencing, barriers, noisemakers, and other practices that may reduce intrusions.
- Train harvest employees to recognize and report evidence (e.g., feces) of animal activity.
- Pooled water (e.g., a seasonal lake) from rainfall may attract animals and should be considered as part of any land use evaluation.
- Consider controlling risks associated with encroachment by urban development. Risks may include, but are not limited to, domestic animal fecal contamination of production fields and harvest equipment and septic tank leaching.

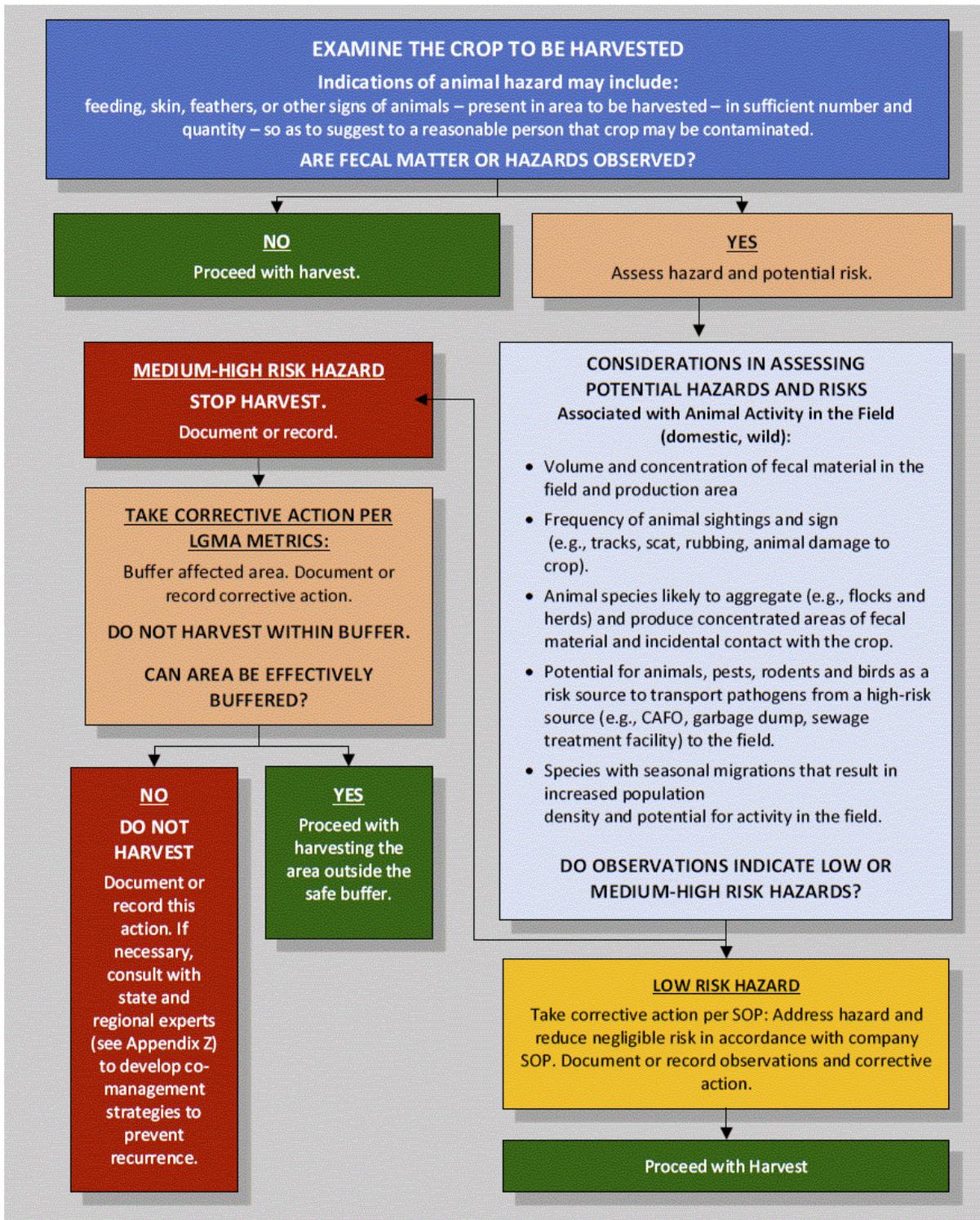


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- After a significant event (such as flooding or an earthquake) that could negatively impact a sewage or septic system, takes appropriate steps to ensure that sewage and septic systems continue to operate in a manner that does not contaminate produce, food contact surfaces, areas used for produce handling, water sources, or water distribution systems.
- Growers are encouraged to contact the relevant agencies (e.g., the Regional Water Quality Control Board and state and federal fish and wildlife agencies) to confirm the details of these requirements. In addition, growers may wish to consult with local USDA Natural Resources Conservation Service (NRCS) staff to evaluate the food safety risks associated with wildlife, livestock, domestic animals and other adjacent land uses and to develop and document strategies to manage or reduce the introduction of human pathogens for each production block.



985 FIGURE 8. PRE-HARVEST and HARVEST Assessment – Animal Hazard/Fecal Matter Decision Tree





987 **TABLE 6. Animal Hazard in Field (Wild or Domestic)**  
988 When evidence of animal intrusion in a production block occurs.

Issue	Metric	Remedial Actions
<b>Evidence of Intrusion</b>	<p><u>Frequency</u></p> <ul style="list-style-type: none"> <li>There shall be a periodic monitoring plan in place for production fields.</li> <li>There shall be Pre-Season, Pre-Harvest, and Harvest Assessments</li> </ul> <p><u>Variables</u></p> <ul style="list-style-type: none"> <li>Physical observation of animals in the field</li> <li>Downed fences</li> <li>Animal tracks in production block</li> <li>Animal feces or urine in production block</li> <li>Damaged or eaten plants in production block</li> </ul>	<ul style="list-style-type: none"> <li>If there is evidence of intrusion by animals, the production block must undergo a detailed food safety assessment by appropriately trained food safety personnel (see Glossary) prior to harvest, as defined in the text of this document.</li> <li>Animal intrusion events shall be categorized as low or medium/high hazard. An example of a low hazard might be a sign of animal intrusion into the leafy green production area by a single small animal or solitary bird with minimal to no fecal deposition.</li> <li>Corrective actions for “Low hazard” animal intrusion shall be carried out according to company SOP.</li> <li>Corrective actions for “medium/high hazard” animal intrusion shall be carried out per the accepted LGMA metrics and must include food safety buffers and do not harvest areas.</li> <li>In developing preventive remedial and corrective actions, consider consulting with wildlife and/or domestic animal experts as appropriate.</li> <li>If remedial actions, such as appropriate no harvest buffers, cannot be formulated to control or eliminate the identified risk, do not harvest and instead destroy the contaminated crop.</li> <li>Equipment used to destroy crop must be cleaned and sanitized upon exiting the field.</li> <li>Formulate effective corrective actions. Prior to taking action that may affect natural resources, growers should check local, state and federal laws and regulations that protect riparian habitat and wetland areas, restrict removal of vegetation or habitat, or regulate wildlife deterrence measures, including hazing, harassment, lethal and non-lethal removal, etc.</li> <li>Food safety assessments and corrective actions shall be documented and available for verification for a period of two years.</li> </ul>



Issue	Metric	Remedial Actions
<b>Allowable Harvest Distance from Evidence of Intrusion</b>		
<p><b>Please see Figure 8. Decision Tree for Conducting Pre-Harvest and Harvest Assessments.</b></p> <p><u>Monitoring</u></p> <ul style="list-style-type: none"> <li>• Conduct periodic monitoring and pre-season, pre-harvest, and harvest assessments. Evaluate and monitor animal activity in and proximate to lettuce/leafy greens fields and production environments.</li> </ul> <p><u>Pre-Harvest Assessment and Daily Harvest Assessment:</u></p> <ul style="list-style-type: none"> <li>• Conduct the pre-harvest assessment not more than one week prior to harvest.</li> <li>• Conduct the daily harvest assessment on each day of harvest.</li> </ul> <p><u>Fecal Material</u></p> <ul style="list-style-type: none"> <li>• Do not harvest any produce that has come into direct contact with fecal material.</li> <li>• If evidence of fecal material is found, conduct a food safety assessment using qualified personnel. Do not harvest any crop found within a minimum 5-foot radius buffer distance from the spot of the contamination unless remedial action can be found that adequately control the risk. The food safety professional can increase this buffer distance if deemed appropriate.</li> </ul> <p><u>Intrusion</u></p> <ul style="list-style-type: none"> <li>• If evidence of animal intrusion is found in a production field, conduct a visual food safety assessment to determine whether the intrusion is a probable (medium/high hazard) or negligible (low hazard) risk. Low hazard (negligible risk) can be corrected by following a company SOP. Medium to high hazard (probable risk) intrusion should include a three-foot buffer radius around a do not-harvest area where the impacted crop has been isolated.</li> </ul> <p><u>Daily Harvest Assessment ONLY</u></p> <p>If evidence of medium/high hazard risk animal intrusion into the production block is not discovered until harvest operations:</p> <ul style="list-style-type: none"> <li>• Stop harvest operations.</li> <li>• Initiate an intensified block assessment for evidence of further contamination and take appropriate actions per the aforementioned actions.</li> <li>• If evidence of intrusion is discovered during production block harvest operations and the harvest rig has been potentially contaminated by contaminated product or feces, clean and sanitize the equipment before resuming harvest operations.</li> <li>• Require all employees to wash and sanitize their hands/gloves before resuming harvest operations.</li> <li>• If contamination is discovered in harvest containers such as bins/totes, discard the product, and clean and sanitize the container before reuse.</li> </ul>		
<b>Verification</b>		
<ul style="list-style-type: none"> <li>• Archive documentation for a period of two years following the intrusion event. Documentation may include photographs, sketched maps, or other means of delineating affected portions of production fields.</li> </ul>		
<b>Rationale</b>		
<ul style="list-style-type: none"> <li>• The basis of these metrics is qualitative assessment of the relative risk from a variety of intrusions. Some animal feces and some signs of intrusion (feces vs. tracks) are considered to be of more concern than others. Because it is difficult to develop quantitative metrics for these types of risks, a food safety assessment is considered appropriate for this issue.</li> <li>• Individual companies need to make the determination as to the level of hazard after considering the following risk factors: the concentration and volume of fecal matter, frequency of animals (observed or indicators) in the field, density of animal population and surrounding area risk – all identified during a risk assessment. A trained food safety professional should be involved in decisions related to animal intrusion. See Appendix B for more details on the qualifications for this person.</li> <li>• Appendix B describes in detail the process used to develop these metrics</li> </ul>		



990 TABLE 7. Crop Land and Water Source Adjacent Land Use

Land Use/Water Source	Metric (This distance may be either increased or decreased depending on risk and mitigation factors.)	Considerations for Risk Analysis*		
		Risk/Mitigation Factors	Increase Distance	Decrease Distance
<b>Composting Operations</b> (manure or animal products)	Due to the lack of science at this time an interim guidance distance of 400 ft. from the edge of crop can occur. This number is only a reference and subject to change as more science becomes available.  The proximate safe distance depends on the risk/mitigation factors listed to the right. Evaluate risk and document consideration of these factors. Research is being proposed to study appropriate distance.	Distance from active compost operation	--	--
		Topography: Uphill from crop	√	
		Topography: Downhill from crop		√
		Opportunity for water run off through or from composting operations	√	
		Opportunity for soil leaching	√	
		Presence of physical barriers such as windbreaks, diversion ditches, vegetative strips		√
<b>Concentrated Animal Feeding Operations</b> (as defined in 40 CFR 122.23)	Distance from a CAFO is not sufficient to address/manage all potential hazards that may be associated with growing leafy greens in proximity to a CAFO. Due to the lack of science at this time interim guidance distances from the edge of a CAFO are established as follows:  >1000 head – 1200 feet >80,000 head – 1 mile  These numbers are only references and subject to change as science becomes available. The proximate safe distance depends on many risk mitigation factors. These distances may increase or decrease after assessing the risk, determining and deploying mitigation measures and consulting with customers.	Fencing and other physical barriers such as berms, diversion ditches and vegetated strips can be employed to prevent intrusion of domestic animals, control runoff, etc.		√
		Topography: Uphill from crop	√	
		Topography: Downhill from crop		√
		Opportunity for water run off through or from CAFOs	√	
		Opportunity for soil leaching	√	
		Manure Management Program utilized		√
<b>Non-synthetic Soil Amendment Pile</b>	Due to the lack of science at this time, an interim guidance distance of 400 ft. from the edge of crop can occur. This number	Access and review COA for materials in question		√
		Topography: Uphill from crop	√	
		Topography: Downhill from crop		√



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Land Use/Water Source	Metric (This distance may be either increased or decreased depending on risk and mitigation factors.)	Considerations for Risk Analysis*		
		Risk/Mitigation Factors	Increase Distance	Decrease Distance
(containing manure or animal products)	is only a reference and subject to change as science becomes available.  The proximate safe distance depends on the risk/mitigation factors listed to the right. Evaluate risk and document consideration of these factors. Research is being proposed to study appropriate distance. For non-synthetic crop treatments that have been heat treated using a validated process an interim guidance distance of 30 feet from the edge of the crop is proposed	Opportunity for water run off through or from CAFOs	√	
		Opportunity for soil leaching	√	
		Manure Management Program utilized		√
		Covering on pile to prevent wind dispersion		√
<b>Grazing Lands/Domestic Animals</b> (includes homes with hobby farms, and non-commercial livestock)	30 ft. from the edge of crop.	Fencing and other physical barriers such as berms, diversion ditches and vegetated strips can be employed to prevent intrusion of domestic animals, control runoff, etc.		√
		Topography: Uphill from crop	√	
		Topography: Downhill from crop		√
		Opportunity for water run off through or from grazing lands	√	
		Opportunity for soil leaching	√	
<b>Homes or other building with a septic leach field</b>	30 ft. from the edge of crop to the leach field.	Active leach field: < 10 yrs old		√
		Active leach field: > 25 yrs old	√	
		Inactive leach field		√
		Topography: Uphill from crop	√	
		Topography: Downhill from crop		√
		Physical barriers		√
		Topography: Uphill from manure		√



Land Use/Water Source	Metric (This distance may be either increased or decreased depending on risk and mitigation factors.)	Considerations for Risk Analysis*		
		Risk/Mitigation Factors	Increase Distance	Decrease Distance
<b>Well Head Distance from Untreated Manure</b>	200 ft. separation of untreated manure from wells, although less distance may be sufficient.	Topography: Downhill from manure	√	
		Opportunity for water runoff from or through untreated manure to well head	√	
		Opportunity for soil leaching	√	
		Presence of physical barriers such as windbreaks, diversion ditches, vegetative strips		√
<b>Surface Water Distance from Untreated Manure</b>	At least 100 feet separation for sandy soil and 200 feet separation for loamy or clay soil (slope less than 6%; increase distance to 300 feet if slope greater than 6%) is recommended.	Topography: Uphill from manure		√
		Topography: Downhill from manure	√	
		Opportunity for water runoff from or through untreated manure to surface waters.	√	
		Opportunity for soil leaching	√	
		Presence of physical barriers such as windbreaks, diversion ditches, vegetative strips		√
<b>Rationale</b>	The bases for these distances above is best professional judgment of authors, contributors, and expert reviewers to prevent potential cross-contamination from adjacent land uses, taking into consideration the 200 foot distance cited in FDA (US FDA 2001) for separation of manure from wellheads and the 30 foot turn-around distance for production equipment. Because of the numerous factors that must be taken into account to determine appropriate distances, a qualitative assessment of the relative risk from various types of land use and surface waters was used to determine appropriate distances.			

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992 Growers should check for local, state and federal laws and regulations that protect riparian habitat, restrict removal of vegetation or habitat, or restrict construction of wildlife deterrent  
 993 fences in riparian areas or wildlife corridors. Growers may want to contact the relevant agencies (e.g., the Regional Water Quality Control Board and state and federal fish and wildlife  
 994 agencies) to confirm the details of these requirements.



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## 16. ISSUE: SOIL FERTILITY/CADMIUM MONITORING & MANAGEMENT PROGRAM

996 Because cadmium is a naturally occurring component of all soils, all plants will contain some cadmium. Some  
997 plants such as spinach are more efficient at taking up naturally occurring cadmium than others. This section is  
998 intended to address this issue through an industry program of soil fertility assessments that shall be completed  
999 and documented prior to the first use of a growing field specific to spinach production and subsequent use over  
1000 time. These soil assessments are intended to identify any issues related to cadmium levels found in the soil that  
1001 are subject to root uptake and incorporation into the spinach tissue and if necessary, to implement science based  
1002 mitigation steps as appropriate, to help reduce uptake levels in the spinach product grown on these soils.

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### THE BEST PRACTICES ARE:

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- Prior to the first use of ground for spinach production an assessment of potential production locations shall be conducted and a management plan developed.
  - First, a review of soil fertility including historical data, established maps, analysis and other reliable sources -- shall be used to determine if the location falls into known regions where cadmium is present.
  - Second, if the review shows cadmium may present a risk, then an SOP addressing fertility management and mitigation shall be created.
    - Soil sampling and analysis must be conducted to establish baseline levels of cadmium in soils intended for spinach production.
    - Results from sampling and analysis should be used by growers to guide, as necessary, mitigation.
    - Resources on sampling and analysis methodologies are provided in Appendix X.
    - Resources on best management practices are provided in Appendix Y.

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## 17. TRANSPORTATION

1018 When transporting lettuce/leafy greens on the farm or from the farm to a cooling, packing, or processing facility,  
1019 manage transportation conditions to minimize the risk of contamination. Food contact surfaces on transportation  
1020 equipment and in transporter vehicle cargo areas that are not properly maintained are potential sources of  
1021 contamination.

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### THE BEST PRACTICES ARE:

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- Visually inspect all shipping units and equipment used to transport leafy greens on the farm or from the farm to a cooling, packing, or processing facility to ensure they are:
  - In good, working condition; and
  - Clean before use in transporting lettuce/leafy greens

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## 18. DETAILED BACKGROUND GUIDANCE INFORMATION

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### REQUIRED REFERENCE DOCUMENTS

1030

1. FDA Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables  
([www.foodsafety.gov/~dms/prodguid.html](http://www.foodsafety.gov/~dms/prodguid.html))

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2. UFFVA Food Safety Auditing Guidelines: Core Elements of Good Agricultural Practices for Fresh Fruits and Vegetables

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3. UFFVA Food Safety Questionnaire for Fresh Fruits and Vegetables

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4. National GAPs Program Cornell University: Food Safety Begins on the Farm: A Grower Self-Assessment of Food Safety Risks

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## REFERENCES

1038

CCR Title 14 - Chapter 3.1 - Article 5. 2007. *Article 5. Composting Operation and Facility Siting and Design Standards*. Accessed February 15, 2007.  
<http://www.ciwmb.ca.gov/regulations/Title14/ch31a5.htm#article5>

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Fonseca JM, Fallon SD, Sanchez CA, and Nolte KD. 2010. *Escherichia coli* survival in lettuce fields following its introduction through different irrigation systems. *Journal of Applied Microbiology*, 110:893-902.

Fukushima H, Hoshina K, and Gomyoda M. 1999. Long-term survival of shiga toxin-producing *Escherichia coli* O26, O111, and O157 in bovine feces. *Applied and environmental microbiology* 65 (11):5177-81.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=10543842](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10543842)

Gagliardi JV and Karns JS. 2000. Leaching of *Escherichia coli* O157:H7 in diverse soils under various agricultural management practices. *Applied and environmental microbiology* 66 (3):877-83.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=10698745](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10698745)

1041  
1042  
1043

Gutierrez-Rodriguez E, Gundersen A, Sbodio A, and Suslow TV. 2012. Variable agronomic practices, cultivar, strain source and initial contamination dose differentially affect survival of *Escherichia coli* on spinach. *Journal of Applied Microbiology*, 112(1):109-118.

1044  
1045  
1046  
1047

Gutierrez-Rodriguez E, Gundersen A, Sbodio A, Koike S, and Suslow TV. 2019. Evaluation of post-contamination survival and persistence of applied attenuated *E. coli* O157:H7 and naturally-contaminating *E. coli* O157:H7 on spinach under field conditions and following postharvest handling. *Food Microbiology*, 77:173-184.

Islam M, Doyle MP, Phatak SC, Millner P, and Jiang X. 2004. Persistence of enterohemorrhagic *Escherichia coli* O157:H7 in soil and on leaf lettuce and parsley grown in fields treated with contaminated manure composts or irrigation water. *Journal of food protection* 67 (7):1365-70.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=15270487](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15270487)

Jiang X, Morgan J, and Doyle MP. 2003. Fate of *Escherichia coli* O157:H7 during composting of bovine manure in a laboratory-scale bioreactor. *Journal of food protection* 66 (1):25-30.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=12540177](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=12540177)

Jiang X, Morgan J, and Doyle MP. 2002. Fate of *Escherichia coli* O157:H7 in manure-amended soil. *Applied and environmental microbiology* 68(2):2605-9.

1048  
1049

Koike S, Cahn M, Smith R, and Suslow T. 2009. Survival and biology of *E. coli* under field production environments. CA Leafy Greens Research Board.

1050  
1051

Moyne AL, Sudarshana MR, Blessington T, Koike ST, Cahn MD, Harris LJ. 2011. Fate of *Escherichia coli* O157:H7 in field-inoculated lettuce. *Food Microbiology*, 28:1417-25.

Solomon EB, Pang HJ, and Matthews KR. 2003. Persistence of *Escherichia coli* O157:H7 on lettuce plants following spray irrigation with contaminated water. *Journal of food protection* 66 (12):2198-202.



[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=14672213](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=14672213)

Stine SW, Song I, Choi CY, and Gerba CP. 2005. Application of microbial risk assessment to the development of standards for enteric pathogens in water used to irrigate fresh produce. *Journal of food protection* 68 (5):913-8.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=15895721](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15895721)

Suslow TV, Oria MP, Beuchat LR, Garrett EH, Parish ME, Harris LJ, Farber JN, Busta FF. 2003. Production practices as risk factors in microbial food safety of fresh and fresh-cut produce. *Comprehensive Reviews in Food Science and Food Safety* 2S:38-77.

1052 Suslow TV, Koike S, Smith R, and Cahn M. 2010. Comparison of surrogate *E. coli* survival and epidemiology in the  
1053 phyllosphere of diverse leafy green crops. Center for Produce Safety, Final report.

Takeuchi K and Frank JF. 2000. Penetration of *Escherichia coli* O157:H7 into lettuce tissues as affected by inoculum size and temperature and the effect of chlorine treatment on cell viability. *Journal of food protection* 63 (4):434-40.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=10772206](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=10772206)

Takeuchi K, Matute CM, Hassan AN, and Frank JF. 2000. Comparison of the attachment of *Escherichia coli* O157:H7, *Listeria monocytogenes*, *Salmonella* Typhimurium, and *Pseudomonas fluorescens* to lettuce leaves. *Journal of food protection* 63 (10):1433-7.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=11041147](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=11041147)

Takeuchi K, Hassan AN, and Frank JF. 2001. Penetration of *Escherichia coli* O157:H7 into lettuce as influenced by modified atmosphere and temperature. *Journal of food protection* 64 (11):1820-3.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=11726166](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=11726166)

US EPA. 1996. *Soil Screening Guidance: Technical Background Document*. EPA/540/R95/128: Office of Solid Waste and Emergency Response, United States Environmental Protection Agency.

[http://rais.ornl.gov/homepage/SSG\\_nonrad\\_technical.pdf](http://rais.ornl.gov/homepage/SSG_nonrad_technical.pdf)

US EPA. 2002. *Implementation Guidance for Ambient Water Quality Criteria for Bacteria: May 2002 Draft*. EPA-823-B-02-003: United States Environmental Protection Agency.

<http://www.epa.gov/waterscience/standards/bacteria/bacteria.pdf>

US FDA. 2001. Chapter II: Production Practices as Risk Factors in Microbial Food Safety of Fresh and Fresh-Cut Produce. In *Analysis and Evaluation of Preventive Control Measures for the Control and Reduction/Elimination of Microbial Hazards on Fresh and Fresh-Cut Produce*; pp.

<http://www.cfsan.fda.gov/~comm/ift3-2a.html>.

US FDA. 2004. Federal Food, Drug, and Cosmetic Act. <http://www.cfsan.fda.gov/~lrd/cfr110.html>

Wachtel MR, Whitehand LC, and Mandrell RE. 2002a. Association of *Escherichia coli* O157:H7 with pre-harvest leaf lettuce upon exposure to contaminated irrigation water. *Journal of food protection* 65 (1):18-25.



[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=11808792](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=11808792)

Wachtel MR, Whitehand LC, and Mandrell RE. 2002b. Prevalence of *Escherichia coli* associated with a cabbage crop inadvertently irrigated with partially treated sewage wastewater. *Journal of food protection* 65 (3):471-5.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=11899045](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=11899045)

Williams TR, Moyne AL, Harris LJ, Marco ML. 2013. Season, irrigation, leaf age, and *Escherichia coli* inoculation influence the bacterial diversity in the lettuce phyllosphere. *PLoS One*, 8(7):e68642.

1054 Wood JD, Bezanson GS, Gordon RJ, and Jamieson R. 2010. Population dynamics of *Escherichia coli* inoculated by  
1055 irrigation into the phyllosphere of spinach grown under commercial production conditions. *International*  
1056 *Journal of Food Microbiology*, 143(3):198-204.

1057 *I of Food Microbiology*, 143(3):198-204.

1058