GLOBALG.A.P. US National Technical Working Group (NTWG) Topic Guideline:

Environmental Monitoring Program

Introduction

The **US National Technical Working Group (NTWG)** has developed this guideline to help producers meet the IFA, HPSS, and PHA principles and criteria. It outlines a general approach for developing an environmental monitoring program (EMP) for postharvest operations that aligns with GLOBALG.A.P. standards. Producers should adapt the guidance by creating procedures, documents, and records that reflect their specific operations.

This guideline is intended for users who are new to GLOBALG.A.P. or transitioning from another standard. Its purpose is to help growers determine whether an environmental monitoring program is needed and to support the development of an appropriate program. The developed sampling frequency should be based on the program's purpose and the level of risk within the operation. This guide does not prescribe a specific approach or testing frequency.

What is an Environmental Monitoring Porgam?

➤ An environmental monitoring program is a systematic process of testing the postharvest handling environment for the presence of indicator organisms or pathogens in order to verify existing sanitation effectiveness, detect and prevent pathogen establishment, and ensure that the facility does not become a source of contamination. **An EMP is a program, not merely a testing event**. It encompasses the full cycle of sampling, analysis, interpretation, and corrective action, and it should be designed to align with and inform the operation's sanitation program.

Why do an Environmental Monitoring Program?

➤ An EMP helps producers identify harborage sites or "hot spots" before they become a source of contamination for the produce being handled. By regularly monitoring the environment, a producer can verify that cleaning and sanitation efforts are working as intended and can focus those efforts where they matter most. An EMP also provides objective data for identifying specific equipment, surfaces, niches, or areas that may pose an elevated risk of contamination, allowing for targeted corrective actions before a problem reaches the product.

When to do an Environmental Monitoring Program?

➤ Whether a formal EMP is required depends first on whether your certification standard or country of production regulations mandates it. Even where an EMP is not explicitly mandated, a risk assessment of the postharvest operation will often point toward one. Operations that handle ready-to-eat commodities, use wet or humid environments, operate year-round, or have a history of positive test results carry higher inherent risk and are strong candidates for a formal program. Smaller, dry-pack operations with minimal handling steps may have a lower risk profile, but should still document the reasoning behind their decision.

➤ **Use the decision flow on Page 3 as a starting point.** In all cases, the conclusions of your risk assessment — and the rationale for the frequency and scope of monitoring you select — should be documented and available.

What are the benefits of an Environmental Monitoring Program?

A strong EMP provides practical benefits beyond certification requirements.

➤ **First, it gives producers early warning of contamination risks.** Finding *Listeria spp.*, for example, in a Zone 3 or Zone 4 area is valuable information that allows corrective action before the organism migrates to a food-contact surface. The significance of a positive result depends on where it is found and the frequency of detection: *Listeria spp*. in Zone 4 is commonly detected and less alarming, consecutive positives in Zone 2 location is a warning, whereas the same organism in Zone 1 (a food-contact surface) demands immediate investigation and response.

➤ **Second, EMP data continuously improves the sanitation program.** Trends in test results reveal whether particular shifts, seasons, or equipment changes are correlated with increased contamination risk, enabling producers to make targeted, evidence-based improvements rather than blanket responses.

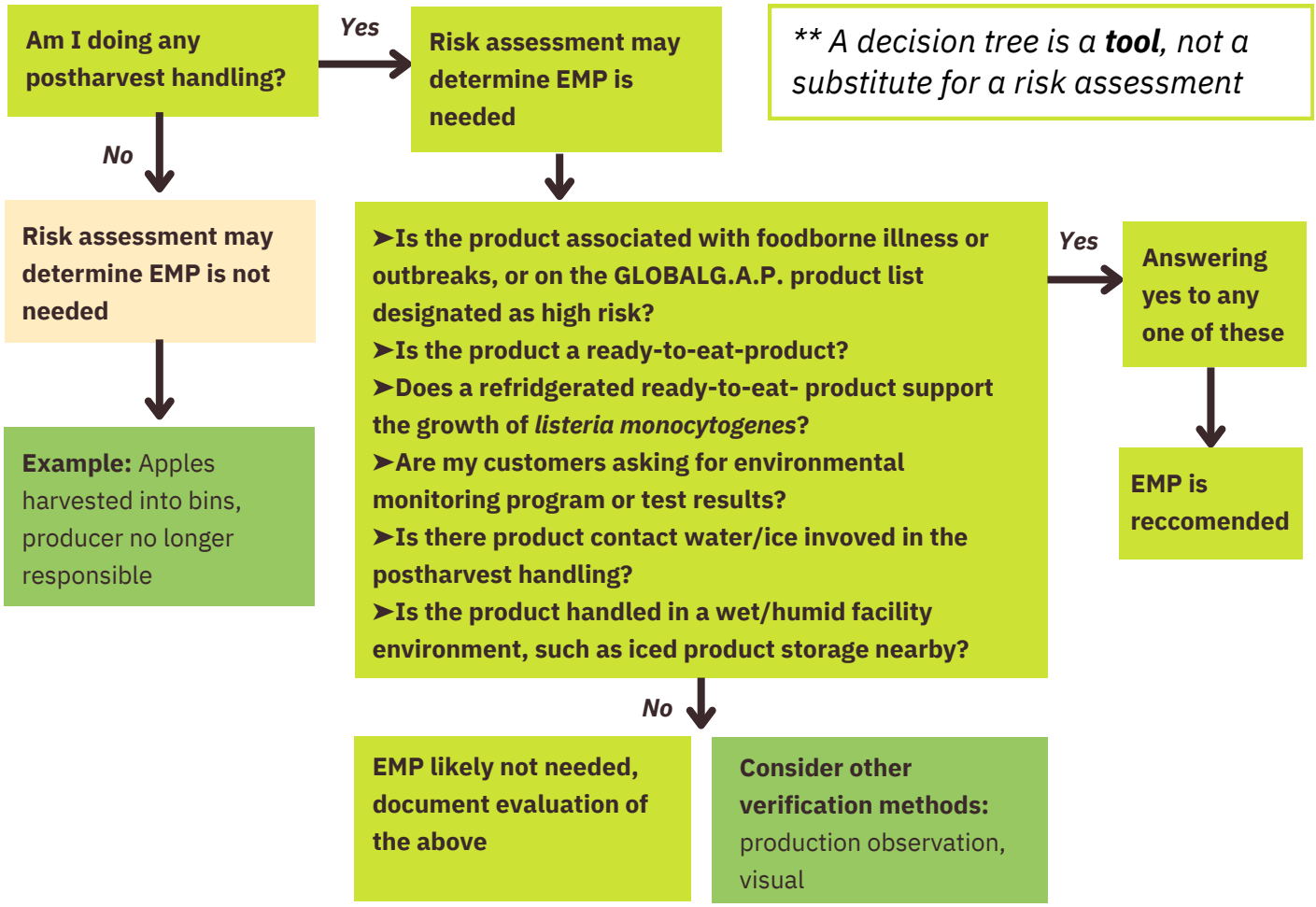
➤ **Third, a documented EMP supports the producer in audits and investigations by demonstrating that proactive monitoring and corrective action are embedded in the operation.** This record of diligence can be critical in defending the operation's practices if a food safety concern arises.

➤ **Fourth, EMP investigations support producers with equipment design evolution.** During an investigation, the operation might discover structural flaws in equipment where pathogens "hide", such as crevices, dead zones, or areas of poor drainage. Operations then can redesign equipment to be completely smooth, self-draining, or easier to clean, such as with rapid, tool-free disassembly. This can eliminate hot spots and reduce sanitation or downtime.

Risk Assessment & Decision Flow

➤ **A Risk Assessment drives your EMP, not the other way around.**
Before deciding what to test, where to test, and how often to test, complete a Risk Assessment of your postharvest operation. The Risk Asesssment identifies the hazards present, the areas of highest concern, and the controls already in place. Your EMP should be sized to match the actual risk profiile of the operation, not a generic template.

Decision Tree - Postharvest Handling EMP FLOW



➤ Know what you are going to do with the results before you take any tests!

What do I need to test for?

The pathogens and indicators you test for should be determined by your risk assessment. The most commonly tested organism in postharvest environmental monitoring is *Listeria spp*., because *Listeria* is ubiquitous in agricultural environments, can survive and multiply at refrigeration temperatures, and its presence in the environment is a reliable signal that sanitation practices may be failing. Other common targets include *E. coli*, total coliforms, Enterobacteriaceae, and ATP *(*adenosine triphosphate*)*. It is important to note that ATP is not a substitute for indicator pathogen testing. ATP measures the presence of organic residues and is useful as a rapid check of cleaning effectiveness, but a low ATP reading does not mean the surface is free of pathogens. The table below summarizes the main types of testing and their respective purposes, benefits, and drawbacks.

Note:

➤ Pathogens and indicators you test for are based on your risk assessment. Testing for specific pathogens (such as *Salmonella* or *Listeria monocytogenes*) is rarely used for routine monitoring and is more appropriate for investigations and research. Consider both the purpose of testing (monitoring vs. investigation) and the zone being sampled when selecting what to test for.

➤ Rapid tests provide quick, on-site results and a positive is a flag to investigate further; laboratory testing provides confirmed, auditable results required for corrective action decisions.

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What do I need to test for?

What to test for	Where does this come from	Purpose	Benefits	Drawbacks
ATP (adenosine triphosphate)	A biochemical substance present in every cell of living organisms and also found in residues from organic sources such as fruit and vegetable debris, microorganisms, bacterial biofilms, and contamination from workers.	Indicates the presence of soil and residues on equipment, helping determine the effectiveness of the cleaning process.	Results can be read within minutes, allowing for a quick check and timely corrective actions.	Cannot distinguish between pathogenic bacteria and other food residues. Facilities may have difficulty determining an appropriate threshold; operations should collect data to establish a science-based threshold. Detergents and sanitizers (especially oxidizers such as hydrogen peroxide) may interfere with results, potentially causing falsely low readings. Sampling can be inconsistent, as swabbing results depend on pressure and contact time.
Total Coliforms	Bacteria found naturally in environmental sources, such as water, soil, and vegetation.	Indicator for sanitary quality of water and sanitary condition in the food-processing environment.	Cost-effective. Is generally cheaper (and faster) than testing for pathogens.	Unreliable indicators of contamination, especially in fresh fruits and vegetables. Not the best indicator for sanitary quality for pre-harvest water. This group does not include pathogens such as viruses, parasites, and bacterial pathogens such as *Salmonella.*
Fecal Coliforms	Types of total coliform bacteria that mostly exist in feces of warm-blooded animals, including humans. While others in this group may originate from fecal matter, they also can originate from environmental sources (such as soil, water, vegetation, decaying organic matter).			
Escherichia coli (E. coli)	Bacteria that are abundant in human and animal feces, not usually found in other sources.	Indicates recent fecal contamination or unsanitary processing.	Generic *E. coli* is a strong indicator of contamination from animal or human waste. It is a reliable indicator of the sanitary quality of water, including both pre-harvest and post-harvest water. It is present in much higher numbers than pathogens, making it easier and more cost-effective to detect as an early-warning system.	The absence of *E. coli* does not guarantee the absence of other dangerous pathogens (such as *Salmonella* or *Listeria monocytogenes*), nor does its presence guarantee that pathogens are present. Generic *E. coli* can naturally survive, persist, and even multiply in soil, water, and plant material, meaning its detection is not always a direct indicator of recent fecal contamination.

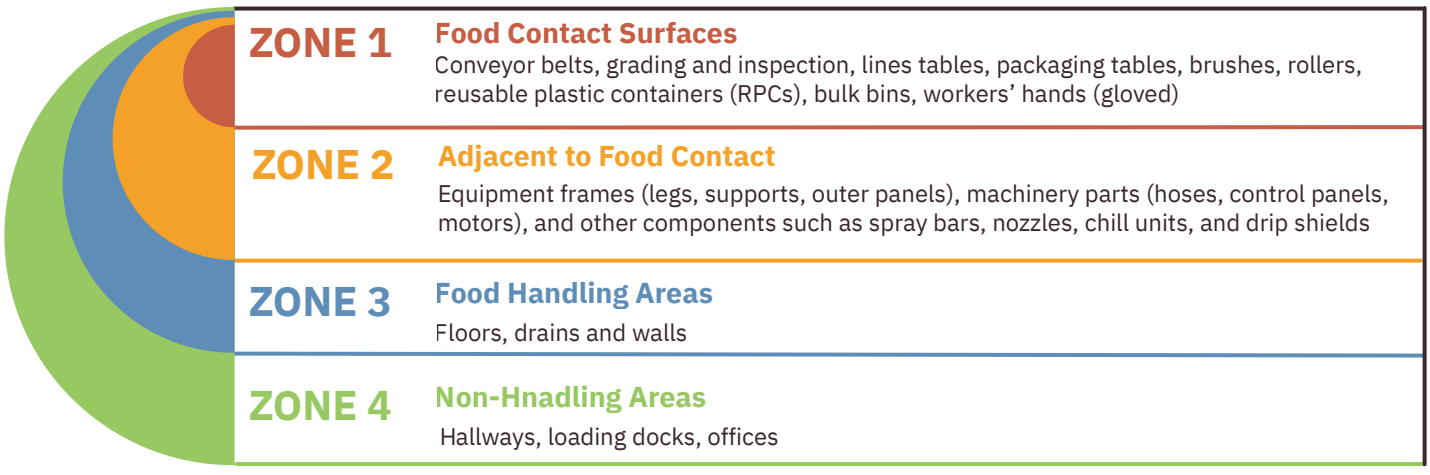
What do I need to test for?

What to test for	Where does this come from	Purpose	Benefits	Drawbacks
Enterobacteriaceae	A large family of bacteria found primarily in the gastrointestinal tracts of humans and animals, as well as in the environment (soil, water, and decaying plant matter). This group includes pathogens such as *Salmonella, Shigella*, and pathotypes of *E. coli*.	Indicator for sanitary condition in the food-processing environment.	Cost-effective. Is generally cheaper (and faster) than testing for pathogens.	Unreliable indicators of contamination, especially in fresh fruits and vegetables, because these naturally carry a wide variety of environmental bacteria. Not indicators of viruses or parasites, as these organisms require different detection methods and are not associated with generic bacterial indicators.
Listeria spp.	These bacteria are ubiquitous in nature (found everywhere in the natural environment) and are well known for their ability to survive and even multiply at cold, refrigerated temperatures.	Used to detect the presence of the *Listeria* genus in food-processing environments and foods. A strong indicator that sanitation controls are failing, as the detection of *Listeria spp*. often signals inadequate cleaning, poor moisture control, or harborage sites. Helps identify "niche" areas where bacteria may be thriving before pathogenic strains (such as *Listeria monocytogenes*) become established.	It serves as a highly cautious and effective early-detection tool for *Listeria monocytogenes*. Finding these organisms suggests that sanitation practices, environmental controls, or zoning measures may not be functioning as intended. For fresh produce, it is recommended to focus on zones 2 and 3 (see Hygienic Zoning) to identify harborage points before the bacteria can reach the produce.	Because *Listeria* is naturally present in agricultural environments such as soil and water, testing often detects non-pathogenic species. These harmless positives can trigger unnecessary supply-chain disruptions, delays, and financial impacts when they are mistaken for the pathogenic *Listeria monocytogenes*.
Specific pathogens, such as *Salmonella* and *Listeria monocytogenes*	Pathogens on fresh fruits and vegetables can come from fecal contamination (human, animal, or manure), contaminated agricultural water, or infected workers with poor hygiene practices.	To detect harmful microorganisms before they reach consumers. Pathogen testing is rarely used for routine monitoring; it is more appropriate for investigations and research.	It helps identify where the contamination started and what caused it (water, soil, worker hygiene). It allows food producers to hold or discard contaminated produce before it reaches consumers.	Because produce batches are large and contamination is often unevenly distributed (pathogens often occur in "hot spots"), it is very difficult to detect a contaminated lot unless contamination levels are high. Testing for every possible pathogen is not practical or cost-effective. Traditional culture methods take several days to produce results, meaning highly perishable produce may already be consumed before contamination is confirmed. Rapid methods exist but are often too expensive for routine use. A negative test result does not guarantee that the entire batch is free of pathogens.

What is hygienic zoning and where do I need to test?

Hygienic zoning is a way of designing and managing a facility by separating it into areas with different cleanliness requirements. The goal is to prevent hazards — **such as pathogens, allergens, or other contaminants** — from moving from dirtier or raw-material areas into spaces where food is exposed and most vulnerable. These zones determine how strict the cleaning, monitoring, and testing need to be in each area. Most facilities use four main zones:

Zone	Definition and examples	Testing implications
Zone 1 (Food contact surfaces)	Any surface that touches fresh produce — including conveyor belts, grading and inspection lines, packaging tables, brushes, rollers, reusable plastic containers (RPCs), bulk bins, workers' hands (gloved or bare), and tools.	Could be routinely tested for indicator organisms such as coliforms and Enterobacteriaceae, and/or ATP to verify that cleaning and sanitation are effective.
Zone 2 (Adjacent to food contact)	Non-food-contact areas located right next to Zone 1. They are close enough that they can transfer pathogens or debris onto food. Examples include equipment frames (legs, supports, outer panels), machinery parts (hoses, control panels, motors), and other components such as spray bars, nozzles, chill units, and drip shields.	Could be routinely tested for indicator organisms such as coliforms and Enterobacteriaceae. They may also be tested for *Listeria spp*. to check whether sanitation is effective and to identify potential harborage sites or niches.
Zone 3 (Food handling areas)	Non-product contact surfaces in food handling areas that are not adjacent to food-contact areas (Zone 1), such as floors, drains, and walls.	Tested less frequently than Zone 2; useful for identifying whether contamination detected in Zone 1 or 2 may be spreading from further-removed environmental sources.
Zone 4 (Non-handling areas)	Includes areas far from food and food-contact surfaces, such as hallways, loading docks, offices. They pose low direct risk.	Zone 4 is usually not part of routine testing. It may be tested occasionally to establish a baseline or to help trace the source of contamination coming from outside the handling area.



How Often Should Sampling be Conducted?

Sampling frequency should be based on the program's purpose and the operation's risk profile. There is no single correct frequency, and this guideline does not prescribe a specific approach. The following factors should all be considered when establishing or reviewing your sampling schedule.

- **Seasonality and operational scope:** A year-round packing operation faces different conditions than one that runs only during harvest season. Wet or humid facilities, cold-storage environments, and operations that use flumes or water-cooling systems carry higher *Listeria* risk than dry-pack operations and may warrant more frequent sampling. The scope and complexity of the facility — whether it includes a single repacking table or a multi-line processing floor — should also shape the sampling plan.
- **Type of produce handled:** Commodities consumed ready-to-eat without a kill step (such as fresh-cut leafy greens or berries) warrant more rigorous monitoring than commodities with a subsequent cooking step.
- **Cleaning and sanitation program:** Areas cleaned and sanitized multiple times per day may be sampled on a different cadence than monthly-cleaned areas. Any changes to the facility — new equipment, building modifications, new products, or changes in personnel — should trigger a review of sampling locations and frequency.
- **History of the program:** If an EMP frequency is too low, then showing a good or bad result trend is difficult. Operations with a history of positive results in particular zones should sample those areas more frequently until the root cause is identified and resolved. Conversely, a sustained record of negative results in low-risk areas may support a reduction in sampling frequency, provided the risk assessment supports that conclusion.
- **Time of day:** Pre-operational sampling (before production begins) tests the effectiveness of the previous sanitation cycle. Sampling after peak production hours captures the highest contamination load accumulated during the shift. The purpose of each sampling event should be clearly defined so that results are interpreted correctly.
- **Applicable regulatory or industry guidelines:** Consult FDA guidance, LGMA standards, or other commodity-specific requirements, as these may set minimum sampling frequencies or specify testing requirements that apply to your operation.

- ➤ End-product testing is final step to monitor/verify sanitary quality of the product.
- ➤ EMP is to identify pathogens in the production environment before they spread.
- ➤ Product testing is generally not part of an EMP program. Producers should review customer requirements regarding end-product testing.

What do I do with the results?

➤ How you respond to test results depends on the type of result, the organism detected, the zone in which it was found, and the thresholds or action levels your program has established. The most important principle is that results should drive decisions — not simply be filed.

➤ Negative results confirm that the area sampled was free of the target organism at the time of sampling. However, consistently negative results should prompt a review of your sampling plan to ensure that locations and timing are being chosen effectively. If every sample is always negative, it may indicate that high-risk areas are not being captured or that sampling is occurring after thorough sanitation rather than under realistic production conditions.

➤ Positive results require a defined corrective action protocol. At a minimum, this should include recleaning and sanitizing the affected area or equipment, retesting to confirm the corrective action was effective, and documenting both the positive result and the corrective action taken. In addition, corrective actions could include vector sampling before corrective action cleaning and sanitation to find the source of contamination. Depending on the organism and the zone, additional steps may be warranted: for a *Listeria spp*. positive in Zone 1 (a food-contact surface), the response should also include an assessment of whether any product in contact with that surface needs to be placed on hold or recalled. For consecutive positives, the response could include a hold on product, root cause analysis and inspection, vector swabbing, and appropriate action (such as cleaning & sanitation changes, equipment changes, etc.) as determined by the RCA.

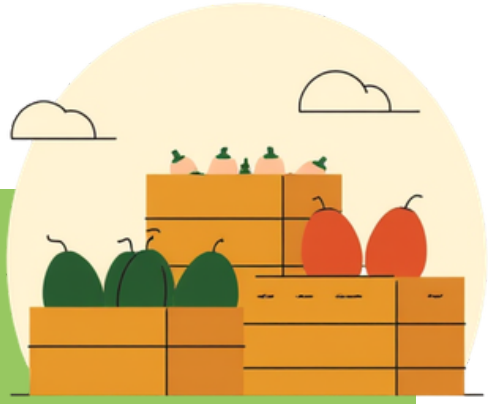
➤ Thresholds and action levels should be established as part of your program design, before you receive your first results. For ATP, operations should gather baseline data from their own facility to set a science-based threshold rather than relying on generic values. For indicator organisms, consult applicable regulatory guidance (such as FDA draft guidance on *Listeria monocytogenes* control for ready-to-eat foods), and any commodity-specific standards. Analytical laboratories may provide additional support. The resources below provide further guidance on establishing thresholds and interpreting results for common tests.

What are the standard Minimum Requirements?

When a hazard scores at or above the action threshold (typically medium), one or more mitigation strategies should be implemented and documented. Strategies move down the list when prior options are not feasible or insufficient — the most reliable controls are those that eliminate the exposure pathway rather than rely on time or treatment alone.

Requirement Area	Summary
Microbial die-off window	Extend the interval between the last water application and harvest so that sunlight, desiccation, and time reduce microbial loads on the crop. Use a documented calculator (e.g., the University of Arizona die-off calculator) and record the interval for every block and harvest
PHA 14.1	The *[microbiological testing and environmental monitoring]* program may be part of the risk assessment or a separate document to verify sanitation of food-contact and non-food-contact surfaces. The risk assessment must consider regulations, customer requirements, and applicable commodity-specific guidance. See Annex 1 – Environmental Monitoring for more information.
HPSS 5.1.1	Operation has initially and at least annually thereafter, performed and documented a hazard analysis of the packinghouse, and has addressed all identified hazards.
FDA FSMA Preventive Controls (21 CFR Part 117)	Ready-to-eat food facilities must use environmental monitoring when contamination by an environmental pathogen is reasonably likely. Testing should cover food-contact surfaces and nearby areas for a pathogen or suitable indicator. For ready-to-eat produce, FDA highlights *Listeria monocytogenes*. Procedures, results, corrective actions, and records must be documented and kept for at least two years.
Additional considerations	Also review commodity-specific, regional, or buyer requirements, which may go beyond minimum regulatory requirements.

References



- ATP testing guidance: https://fieldreport.caes.uga.edu/publications/B1524-3/using-atp-protein-and-allergen-swabs/
- *Listeria* guidance: https://www.freshproduce.com/siteassets/files/reports/food-safety/guidance-on-environmental-monitoring-and-control-of-listeria.pdf
- Hygienic zones: https://fieldreport.caes.uga.edu/publications/B1524-1/packinghouse-environmental-monitoring-programs-identifying-packinghouse-zones/
- FDA draft guidance (*Listeria monocytogenes* control for RTE foods): https://www.fda.gov/regulatory-information/search-fda-guidance-documents/draft-guidance-industry-control-listeria-monocytogenes-ready-eat-foods
- 2nd Edition Neogen® Environmental Monitoring Handbook for the Food and Beverage Industries: https://www.neogen.com/en/usac/neocenter/resources/food-beverage-environmental-monitoring-handbook/#b1630c26-78bb-4844-b0a2-313b650f3e3a_label

Examples

➤ Example Template: ENVIRONMENTAL MONITORING PROGRAM

Purpose: This risk assessment determines whether an environmental monitoring program (EMP) is required for this operation, identifies the areas of highest contamination risk within the facility, and establishes the sampling locations, test targets, frequency, and corrective action protocol for the program. It is reviewed annually and whenever a material change occurs to the facility, equipment, commodity, or operations.

1. **SCOPE**

Facility Description and Scope	*Describe here handling production process, e.g., packing, cooling, number of lines, products handled. Describe product process from entry to exit. Describe any water use. Describe seasonal or short-term operational differences.*

2. **RISK ASSESSMENT**

Topic to Evaluate	Risk Level	Comments
Is there any postharvest handling involved?		
Is the product associated with foodborne illness or outbreaks or listed by GLOBALG.A.P. as a high-risk product?		
Is the product a refrigerated, ready-to-eat item that can support the growth of *Listeria monocytogenes?*		
Does a customer require environmental monitoring?		
Is water or ice in direct contact with the product during postharvest handling?		
Is the product handled in a wet or high-humidity environment, such as areas where iced products are stored nearby?		
Are there any additional considerations relevant to the risk assessment?		

Based on the risk assessment, is Environmental Monitoring required? YES ☐ NO ☐

3. **COMPLETE ONLY IF ENVIRONMENTAL MONITORING IS JUSTIFIED**

Hazard identification and risk level
The table below identifies the key microbial hazards associated with each area of the facility, explains the reasoning behind each risk determination, and assigns a risk level (High / Medium / Low). Risk level is used to prioritize sampling locations and frequency in the sampling plan.

Area/Location /Zone	Hazard Identified	Reasoning	Risk Level
Packing belt (Zone 1)	Listeria spp. harborage in belt seams and under-belt surfaces; Listeria monocytogenes transfer to the product	Direct food-contact surface. Belt seams and edges are difficult to clean thoroughly. Wet surface cleaning increases chance of LM growth.	High

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Examples

➤ Example Template: ENVIRONMENTAL MONITORING PROGRAM

Area/Location /Zone	Hazard Identified	Reasoning	Risk Level
Iced product storage room, ice storage bins (Zone 2)	Listeria spp. harborage in ice-making equipment, storage bins, and scoops; Listeria monocytogenes transfer to product via direct ice contact	Ice is a direct food-contact surface (Zone 1 concern). Listeria monocytogenes survives and can multiply at refrigeration and near-freezing temperatures, making ice-making and storage equipment a high-risk harborage environment.	High
Cold storage room 2 — floors and drains (Zone 3)	Listeria spp. harborage in floor cracks and drain biofilm; cross-contamination to product via foot traffic, equipment wheels, or condensation	Cold and moist floor and drain environments are ideal conditions for Listeria survival and persistence. Although room 2 holds only finished, clam shelled product — reducing the risk of direct surface-to-product transfer — contamination from floors and drains can migrate inward via foot traffic, equipment movement, or condensation drip onto packaging. The room still warrants monitoring as a harborage and migration risk.	Medium
Loading dock / truck bay (Zone 4)	Pathogen introduction from outside environment (vehicle tires, pallets, external foot traffic)	Zone 4 areas are not routinely tested. Risk of direct contamination of product is low, but they can serve as an entry point for organisms that migrate inward.	Low

➤ Example Template: SAMPLING PLAN

Purpose: The sampling plan below defines the sampling sites and primary targets.

Sampling Plan under realistic conditions:	Sites are swabbed after production and before cleaning (for post-production timing) or after cleaning and sanitizing but before production begins (for pre-op timing). This ensures that results reflect true environmental conditions and cleaning effectiveness respectively, rather than artificially low counts from freshly sanitized surfaces.

Location	Description	Zone	Indicator Organism(s) or Parameter	Sample Timing	Frequency	Test Method / Laboratory	Threshold (by Zone)
Packing belt	Seam/under-belt surface	1	Listeria spp.	At least two hours after beginning production	Monthly	AOAC Official Method 2016.07/ Accredited Laboratory	(zero) Absence

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Examples

➤ Example Template: SAMPLING PLAN

RESULTS

Sample Identification	Packaging belt (line)
Laboratory	Accredited Laboratory
Test Conducted	AOAC Official Method 2016.07 for detecting Listeria spp
Date	8/3/2026
Interpretation of Results	First routine sampling positive in a Food Contact Surface (FCS) in a food that does not support growth, requiring further investigation
Action of a Negative Result	N/A
Corrective Action for a Positive Result	Based on Table 6 of FDA's "Control of Listeria monocytogenes in Ready-To-Eat Foods: Guidance for Industry, Draft Guidance", the corrective actions include: Clean and sanitize area of positive • Retest during next production cycle, using a vector sampling approach • Conduct comprehensive investigation
Signed By	Joe Clean, Manger of Food Safety

** **Attach laboratory results, and accreditation/proficiency testing certificates, ensure lab methods used are included in proficiency testing**

Reference: https://www.umass.edu/agriculture-food-environment/sites/ag.umass.edu/files/sample_of_and_environmental_monitoring_protocol_sanitation_preventive_control_0.pdf

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GLOBALG.A.P. US National Technical Working Group (NTWG)
Topic Guideline: **Environmental Monitoring Program**

National technical working groups (NTWGs) consist of GLOBALG.A.P. Community Members, qualified experts, and relevant stakeholders in a specific country. Participants may include producer organizations, certification bodies (CBs), retailers, supply chain members, and more.

Together, **NTWG** members work to identify adaptation and implementation challenges based on local legislation or structural conditions. They then develop guidelines, helping producers and CBs to apply and audit against GLOBALG.A.P. principles and criteria (P&Cs) at a local level.

Interested in joining the **US NTWG**?

Visit www.globalgap.org/about/ntwgs or contact northamerica@globalgap.org.

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