



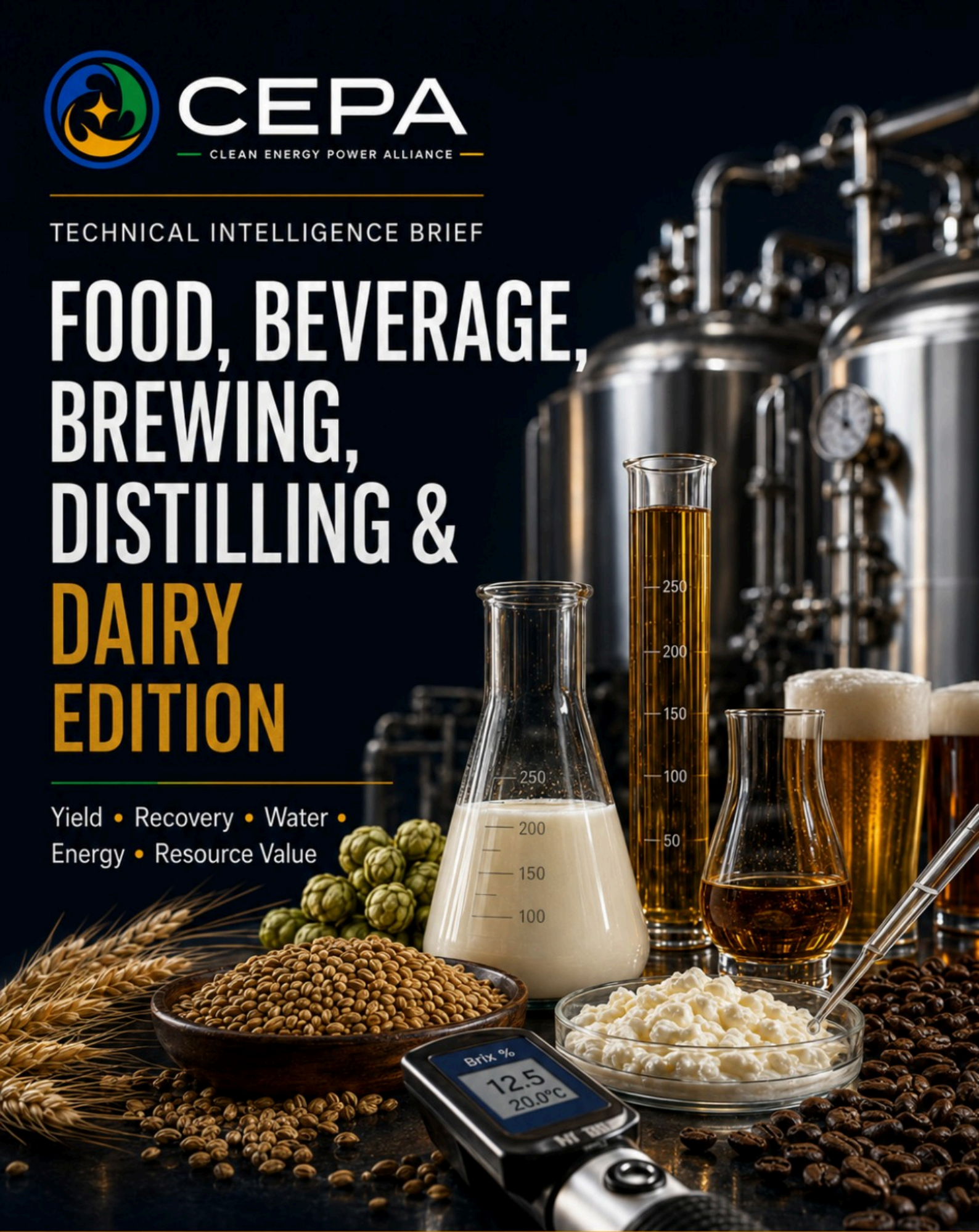
CEPA

CLEAN ENERGY POWER ALLIANCE

TECHNICAL INTELLIGENCE BRIEF

FOOD, BEVERAGE, BREWING, DISTILLING & DAIRY EDITION

Yield • Recovery • Water •
Energy • Resource Value



EDITION COVER • SEPTEMBER 2026

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Prepared by



EterSolis

Waste & Carbon Management



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TECHNICAL INTELLIGENCE BRIEF

FOOD, BEVERAGE, BREWING,
DISTILLING & DAIRY EDITION

CLOSING THE WATER LOOP

Fit-for-Purpose Reuse and
Hygienic Control



1. SOURCE
SEGREGATION



2. TREATMENT



3. MONITORING &
VERIFICATION



4. FIT-FOR-PURPOSE
REUSE



5. RETURN &
CONTROL

ISSUE 002 | 06 SEPTEMBER 2026

CEPA-TIB-FOODBEV-002-20260906

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CEPA TECHNICAL INTELLIGENCE BRIEF | PUBLICATION CONTROL

Closing the Water Loop: Fit-for-Purpose Reuse and Hygienic Control



EterSolis
Waste & Carbon
Management

CEPA-TIB-FOODBEV-002-
20260906

A decision-grade framework for water mapping, segregation, treatment, reuse, monitoring and sanitary release across food, beverage, brewing, distilling and dairy operations.



SCAN FOR CEPA PUBLICATIONS
<https://cepa.energy/publications>

FIELD	VALUE
ISSUE	Issue 002
DATE	6 September 2026
DOCUMENT CODE	CEPA-TIB-FOODBEV-002-20260906
PUBLISHED BY	CEPA
PREPARED BY	EterSolis Waste & Carbon Management
MAIN X HANDLE	@CEPAIntel
EDITION X HANDLE	@CEPAFoodIntel
PUBLIC ACCESS	https://cepa.energy/publications

CONTROLLING EXECUTIVE FINDINGS

- 1 Define water quality by intended end use and exposure pathway; applicable legal minima still control.
- 2 Segregate clean or low-load streams before mixing with high-COD, solids-rich or chemically incompatible streams.
- 3 Treatment performance alone does not authorize reuse; food-safety, product-quality and jurisdictional requirements remain controlling.
- 4 Direct product contact, food-contact surfaces and non-contact utilities require different controls commensurate with exposure.
- 5 Online monitoring shows whether a validated process remains inside its operating envelope; it does not independently establish microbial or chemical safety.
- 6 Quantify burden shifts to energy, chemicals, concentrate, sludge, reject streams and other residuals.
- 7 Evaluate economics using total avoided cost and total new cost - not freshwater tariff alone.

DECISION-GRADE PUBLICATION SYSTEM

Evidence boundary

Source-level measurement

Normalized metric

Technical decision

Verified outcome

FOOD2-001 | Sources: B01, B05, B06, B08, B09, B10, B12

This publication is technical intelligence, not certification or a substitute for jurisdiction-specific legal or regulatory advice.

Scope, hygiene boundary and evidence discipline

KEY

Water-reuse evidence must distinguish international guidance, binding food law, competent-authority requirements, BAT comparators and site-specific validation.

TECHNICAL BASIS

This issue covers ingredient and product-contact water, food-contact-surface rinses, process and utility water, cooling and refrigeration loops, boiler and steam systems, condensates, RO streams, alternative sources, treatment barriers, disinfection, monitoring, verification, chemical hazards, cross-connections, storage, energy, residuals, economics and failure modes.

DECISION INTERPRETATION

No source is used beyond its scope. Codex is international guidance, not a permit. EPA WRAP is a policy/action program, not plant authorization. EU BAT ranges are technical performance comparators, not universal legal limits. 21 CFR and EU hygiene rules control only within their jurisdictions and exact applicability.

CONTROL ACTION

Add jurisdiction, end use and evidence class to every reuse claim.

REQUIRED RECORDS

Source; locator; jurisdiction; end-use category; evidence class; date verified; claim IDs.

AUDIT / ESCALATION TRIGGER

Escalate when a pilot, BAT range or Codex recommendation is presented as legal permission.

FOOD2-002 | Sources: B01, B05, B07, B08, B09, B10 | Claim: claim foodbev002 p02 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Executive water-reuse decision system

KEY

The defensible sequence is source; hazards; end use; applicable legal or authority requirements; treatment barriers; validation; monitoring; verification; and controlled release or diversion.

TECHNICAL BASIS

Fit-for-purpose reuse starts with what the water contains and where it will go. Microbial, chemical and physical hazards require different controls. A stream that is suitable for cooling-tower makeup may be unsuitable for a food-contact rinse; a potable-quality target may be required in one jurisdiction or end use and unnecessary in another.

DECISION INTERPRETATION

Executives should approve reuse pathways, not generic "recycled water." Each approved pathway needs a defined source, treatment train, release criteria, diversion response and regulatory basis. The same treatment system can support multiple uses only if each use is independently justified.

CONTROL ACTION

Create an approved source-to-end-use matrix with release limits and diversion actions.

REQUIRED RECORDS

Source ID; use ID; hazards; legal requirement; treatment barriers; validation result; monitoring parameters; release criteria.

AUDIT / ESCALATION TRIGGER

Escalate any pathway with an undefined end use, undefined legal basis or no automatic response to out-of-spec water.

FOOD2-003 | Sources: B01, B04, B08, B09 | Claim: claim foodbev002 p03 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Water as a process material

KEY

Water carries function, heat, chemistry and contamination; it should be specified and accounted for like any other process material.

TECHNICAL BASIS

Water can be an ingredient, transport medium, wash fluid, rinse, solvent, heating/cooling medium, steam source, product-displacement medium or sanitation utility. Each role has different quality needs and introduces different contaminants. Treating all water as one utility hides both unnecessary potable-water use and high-risk reuse pathways.

DECISION INTERPRETATION

Assign a quality specification to each water function and measure both quantity and quality at the point where the function occurs. Water conservation is strongest when the required quality is no higher than necessary but never lower than safety and product requirements.

CONTROL ACTION

Define a water specification for every major use point.

REQUIRED RECORDS

Use point; required quality; flow; temperature; pressure; contact class; critical contaminants; owner.

AUDIT / ESCALATION TRIGGER

Escalate potable water used in high-volume non-contact applications without a documented reason or reclaimed water used in contact applications without validation.

FOOD2-004 | Sources: B01, B06, B08, B09 | Claim: claim foodbev002 p04 core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Facility-wide water balance

KEY

A controlled water-reuse program requires a reconciled balance of intake, internal transfers, product incorporation, evaporation, discharge, recovery and material losses.

TECHNICAL BASIS

A facility balance should distinguish mains/well/other intake, water in raw materials, condensate and recovered water, water added to product, evaporation, steam loss, cooling-tower evaporation/blowdown, wastewater discharge, residual moisture and inventory in tanks. Metering only the site inlet and final discharge cannot identify reuse opportunities.

DECISION INTERPRETATION

Build the balance hierarchically: site -> process area -> major use -> candidate reuse source. Use a consistent reporting period and reconcile unexplained variance before using intensity metrics for investment decisions.

CONTROL ACTION

Install or validate meters at the major water users and candidate reuse sources.

REQUIRED RECORDS

Opening/closing tank levels; intake meters; process meters; wastewater flow; production denominator; evaporation estimates; meter uncertainty.

AUDIT / ESCALATION TRIGGER

Escalate when unexplained water-balance variance is large enough to change the ranking of reuse opportunities.

FOOD2-005 | Sources: B01, B06, B10 | Claim: claim_foodbev002_p05_core
 Facility-specific metering controls the balance; BAT ranges are comparison evidence only.

Source-to-end-use water mapping

KEY

Reuse opportunities are identified by matching a defined source to a compatible end use before streams are mixed.

TECHNICAL BASIS

Source mapping records where the water came from, what it contacted, chemicals added, temperature, variability and likely hazards. End-use mapping records contact class, product proximity, aerosol potential, worker/public exposure, equipment/material compatibility and required quality. The intersection defines the treatment and validation burden.

DECISION INTERPRETATION

Prioritize short, stable loops where source quality is high and the end-use requirement is lower than or similar to the source quality. Avoid building complex treatment around a mixed wastewater stream when a cleaner source can be segregated upstream.

CONTROL ACTION

Create a source-end-use Sankey or matrix and rank candidate loops by risk and treatment gap.

REQUIRED RECORDS

Source flow; contaminant profile; variability; end-use demand; required quality; temporal match; storage need.

AUDIT / ESCALATION TRIGGER

Escalate when a reuse project depends on averaging incompatible streams that could have been segregated.

FOOD2-006 | Sources: B01, B06 | Claim: claim_foodbev002_006_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Fit-for-purpose water-quality architecture

KEY

Fit-for-purpose means the water quality is adequate for the intended use after considering all relevant hazards and exposure pathways.

TECHNICAL BASIS

Codex supports a risk-based approach in which source, intended use, hazard analysis, treatment and monitoring are connected. This is not permission to lower standards arbitrarily. Food safety, product quality and competent-authority requirements define the minimum acceptable quality, and some uses may require potable-quality water or equivalent controls.

DECISION INTERPRETATION

Create quality classes tied to use categories: ingredient/direct product contact, food-contact surface/final rinse, indirect process contact, closed-loop utility and non-contact utility. Each class should state microbiological, chemical, physical and operational criteria.

CONTROL ACTION

Publish an internal water-quality-class standard with approved end uses.

REQUIRED RECORDS

Microbial criteria; chemical panel; turbidity/solids; conductivity; residual disinfectant; temperature; contact class.

AUDIT / ESCALATION TRIGGER

Escalate any quality class defined only by one indicator such as conductivity or turbidity.

FOOD2-007 | Sources: B01, B04, B08, B09 | Claim: claim foodbev002 p07 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Potable, process, utility and reclaimed-water boundaries

KEY

Water category labels are useful only when they correspond to a defined quality and permitted use.

TECHNICAL BASIS

U.S. CGMP requires water contacting food, food-contact surfaces or packaging to be safe and of adequate sanitary quality. EU hygiene law requires adequate potable water and separation of non-potable systems and places conditions on recycled processing/ingredient water. Codex provides a fit-for-purpose framework that must be applied inside those legal boundaries.

DECISION INTERPRETATION

Do not assume "reclaimed" means non-potable, "process" means food contact or "utility" means low risk. Define each category by measurable quality, contact route and legal basis. Piping identification and physical separation should follow those definitions.

CONTROL ACTION

Create controlled definitions and color/label standards for all water systems.

REQUIRED RECORDS

Water class; specification; legal basis; piping ID; approved uses; prohibited uses; responsible owner.

AUDIT / ESCALATION TRIGGER

Escalate unlabeled cross-connected systems or categories whose name is used as a substitute for a quality specification.

FOOD2-008 | Sources: B01, B08, B09 | Claim: claim foodbev002 p08 core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Microbial, chemical and physical hazard framework

KEY

Microbiological control does not establish chemical safety, and chemical compliance does not establish microbiological control.

TECHNICAL BASIS

Microbial hazards may include pathogens and indicator organisms; chemical hazards can arise from source water, process ingredients, cleaning/sanitation chemistry, corrosion, treatment chemicals, persistent compounds and by-products; physical hazards include particles, turbidity and foreign material. WHO/FAO notes that chemical-water guidance is less mature than microbial guidance and recommends risk-based prioritization.

DECISION INTERPRETATION

Build separate hazard inventories, then identify common controls and interactions. For example, stronger disinfection may improve microbial control while generating chemical by-products or changing corrosion. Reuse design must manage the combined risk without assuming one surrogate captures all hazards.

CONTROL ACTION

Require microbial, chemical and physical hazard sign-off for every contact-class reuse loop.

REQUIRED RECORDS

Source contaminants; process chemicals; corrosion materials; pathogen indicators; treatment chemicals; by-product panel; physical parameters.

AUDIT / ESCALATION TRIGGER

Escalate reuse approved from microbiological validation alone when plausible chemical hazards remain unassessed.

FOOD2-009 | Sources: B01, B04, B11 | Claim: claim_foodbev002_p09_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Segregation before treatment

KEY

Upstream segregation can prevent relatively clean streams from inheriting the treatment burden of high-load or chemically incompatible streams.

TECHNICAL BASIS

Candidate low-load streams can include certain condensates, non-contact cooling waters, selected rinses or membrane permeates, while high-load streams can include product losses, first rinses, brines, strong CIP solutions, fermentation residues or solids-rich waters. Once mixed, the entire flow may inherit the highest treatment burden.

DECISION INTERPRETATION

Use conductivity, COD/TOC, turbidity, temperature, pH and process-event signals to define diversion logic. Segregation should be based on demonstrated quality patterns, not visual appearance alone.

CONTROL ACTION

Install source diversion or dedicated collection where stable quality classes exist.

REQUIRED RECORDS

Flow and quality profile by event; valve logic; diversion destination; tank capacity; contamination upset history.

AUDIT / ESCALATION TRIGGER

Escalate when a high-value low-load stream is routinely sent to mixed wastewater without a documented reason.

FOOD2-010 | Sources: B01, B06, B10 | Claim: claim_foodbev002_p10_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Ingredient and direct product-contact water

KEY

Ingredient and direct product-contact reuse are high-consequence applications and require the strictest applicable legal, food-safety and validation controls.

TECHNICAL BASIS

Codex general principles and national law require particular caution where water becomes part of food or directly contacts product. U.S. CGMP requires water contacting food to be safe and of adequate sanitary quality. EU rules contain specific conditions for recycled water used in processing or as an ingredient and require that it not present contamination risk.

DECISION INTERPRETATION

For generic CEPA guidance, do not authorize a direct-contact reuse application. Instead, define the evidence package required: legal basis, source characterization, validated treatment barriers, microbial and chemical verification, product-quality assessment, monitoring, fail-safe diversion and competent-authority acceptance where required.

CONTROL ACTION

Require executive and food-safety approval for any ingredient/direct-contact reuse pathway.

REQUIRED RECORDS

Legal interpretation; source hazard profile; validation study; product testing; monitoring limits; diversion test; regulator/authority documentation where applicable.

AUDIT / ESCALATION TRIGGER

Escalate any direct-contact pathway justified only by treatment technology capability or potable-like analytical results without legal review.

FOOD2-011 | Sources: B01, B08, B09 | Claim: claim_foodbev002_p11_core
Authorization is jurisdiction- and use-specific; this publication does not grant permission for any specific direct-contact reuse application.

Final rinse and food-contact-surface water

KEY

Final-rinse water can transfer residual chemical or microbiological contamination directly to food-contact surfaces and therefore needs end-use-specific release criteria.

TECHNICAL BASIS

Food-contact surface uses differ from non-contact washdown because the residual water may remain on equipment before food exposure. Relevant controls can include microbiological quality, treatment residuals, chemical contaminants, turbidity/solids, sanitizer compatibility and time between rinse and production.

DECISION INTERPRETATION

Where reclaimed water is considered, validation should test the actual circuit, surface, operating temperature, downtime and residual behavior. A laboratory water sample alone cannot validate the hygienic outcome of the final rinse system.

CONTROL ACTION

Validate final-rinse pathways using both water and surface-release evidence.

REQUIRED RECORDS

Water-quality results; surface verification; sanitizer residual; line hold time; startup release record; corrective action.

AUDIT / ESCALATION TRIGGER

Escalate a reclaimed final-rinse system that lacks surface-level verification or automatic diversion on treatment failure.

FOOD2-012 | Sources: B01, B08, B09 | Claim: claim foodbev002 p12 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Initial rinses and intermediate process water

KEY

Intermediate rinses can be reuse candidates when product, allergen and chemical carryover are measured and controlled rather than assumed.

TECHNICAL BASIS

Initial or intermediate rinse quality changes over the cycle. Early water may contain concentrated product or soil; later water may be relatively clean. Conductivity, turbidity, TOC/COD, pH or product-specific signals can identify quality transitions. Reusing a rinse without allergen or product-family controls can create cross-contamination.

DECISION INTERPRETATION

Use event-based diversion: recover product-rich fractions where appropriate, route contaminated fractions to treatment and capture the quality window that meets a defined secondary use. Do not reuse by fixed time alone when process variability is material.

CONTROL ACTION

Develop sensor-based or validated time/volume diversion windows for stable circuits.

REQUIRED RECORDS

Cycle profile; product family; allergen status; conductivity/TOC/turbidity; diversion setpoint; receiving use specification.

AUDIT / ESCALATION TRIGGER

Escalate rinse reuse across incompatible product/allergen families without validated controls.

FOOD2-013 | Sources: B01, B02 | Claim: claim_foodbev002_013_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Cooling and refrigeration water loops

KEY

Closed or semi-closed cooling systems can support reuse, but higher concentration cycles can increase salts, treatment-chemical demand and microbiological control requirements.

TECHNICAL BASIS

Cooling-tower makeup quality affects scaling, corrosion, biofouling, drift and blowdown. Reclaimed sources can reduce freshwater demand, but higher dissolved solids or nutrients may increase chemical treatment, blowdown or aerosol-related concerns. Refrigeration systems also contain condensate streams with distinct quality and heat-recovery potential.

DECISION INTERPRETATION

Evaluate reuse using both water and energy balances. Increasing concentration cycles may reduce makeup until corrosion, scaling, treatment chemistry or blowdown quality becomes limiting. Source quality must be compatible with metallurgy and microbiological control.

CONTROL ACTION

Build a cooling-water mass and chemistry balance before assigning reclaimed makeup.

REQUIRED RECORDS

Makeup/blowdown flow; conductivity; hardness/alkalinity; chlorides; nutrients; corrosion indicators; biocide residual; drift control.

AUDIT / ESCALATION TRIGGER

Escalate projects that report water savings without measuring additional blowdown, chemical demand or corrosion risk.

FOOD2-014 | Sources: B06, B12 | Claim: claim_foodbev002_014_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Boiler feed, condensate and steam recovery

KEY

Condensate recovery can reduce water and thermal-energy demand, but contamination risk and any product-contact steam requirements must be controlled separately.

TECHNICAL BASIS

Clean condensate can carry substantial sensible heat and low dissolved solids, making return to the boiler system attractive. However, process leaks, additives, carryover or product-contact requirements can change suitability. Steam used directly on food or food-contact surfaces may have additional quality requirements compared with closed utility steam.

DECISION INTERPRETATION

Segregate clean and suspect condensate, monitor for contamination indicators and return only streams that meet boiler/feedwater and hygienic requirements. Count recovered heat as a separate benefit from recovered water.

CONTROL ACTION

Install or validate condensate-quality diversion logic and return metering.

REQUIRED RECORDS

Condensate flow/temperature; conductivity; contamination indicator; treatment chemical; return rate; boiler feed specification.

AUDIT / ESCALATION TRIGGER

Escalate condensate return where heat-exchanger or process leaks cannot be detected reliably.

FOOD2-015 | Sources: B01, B06, B10 | Claim: claim_foodbev002_p15_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

RO permeate, reject and membrane streams

KEY

Membrane permeate and reject are separate products with different value and risk; neither should be labeled simply "treated water" or "waste."

TECHNICAL BASIS

RO and other membrane systems partition contaminants rather than destroy them. Permeate quality depends on membrane integrity, feed water, pretreatment and operating conditions, while reject concentrates salts and other retained constituents. Recovery percentage alone can hide rising concentrate burden or fouling energy.

DECISION INTERPRETATION

Assign a specification and destination to permeate and a mass balance to reject. Monitor parameters that can indicate membrane integrity and use periodic verification for contaminants not captured by online surrogates.

CONTROL ACTION

Reconcile membrane feed = permeate + concentrate + cleaning/hold-up and track salt/contaminant mass.

REQUIRED RECORDS

Feed/permeate/reject flow; conductivity; pressure; normalized flux; integrity indicator; cleaning frequency; reject composition.

AUDIT / ESCALATION TRIGGER

Escalate increasing recovery when concentrate management, fouling or energy demand worsens disproportionately.

FOOD2-016 | Sources: B06, B12 | Claim: claim_foodbev002_016_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Evaporator and process condensates

KEY

Process condensate can look visually clean while carrying volatile organics, entrained product or chemical contaminants that depend on the process.

TECHNICAL BASIS

Evaporation and concentration operations generate condensate with source-specific chemistry. Dairy, beverage and other food processes may create condensates that are reusable after appropriate characterization, but contamination can arise from entrainment, volatile compounds, cleaning events or equipment leaks.

DECISION INTERPRETATION

Characterize condensate by operating state rather than one grab sample. Separate normal production, startup, shutdown and cleaning. Reuse should be tied to a quality window and receiving-use specification.

CONTROL ACTION

Create condensate diversion logic with startup/CIP exclusion unless validated otherwise.

REQUIRED RECORDS

Flow; conductivity; TOC/COD; turbidity; volatile markers where relevant; event state; temperature; receiving-use spec.

AUDIT / ESCALATION TRIGGER

Escalate reuse based only on low conductivity when organic carryover is plausible.

FOOD2-017 | Sources: B01, B03, B10 | Claim: claim_foodbev002_p17_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Rainwater and external alternative-water sources

KEY

Alternative water sources can add source-specific microbial, chemical and physical hazards together with temporal or seasonal variability.

TECHNICAL BASIS

Rainwater, municipal reclaimed water, stormwater or other external sources can reduce potable demand but may introduce microbial, chemical, solids and seasonal variability. Storage can create additional contamination or stagnation. EPA reuse resources emphasize that end-use specifications and state rules vary.

DECISION INTERPRETATION

External-source projects require source agreement/specification, incoming verification, treatment-barrier design, seasonal risk analysis and a backup/diversion strategy. They should normally target lower-consequence uses unless stronger legal and validation evidence supports higher-consequence uses.

CONTROL ACTION

Define approved alternative sources and prohibited connections.

REQUIRED RECORDS

Source contract/spec; seasonal data; microbial/chemical panel; storage conditions; treatment validation; state/local requirements.

AUDIT / ESCALATION TRIGGER

Escalate external alternative water entering the plant without independent incoming verification and clear piping separation.

FOOD2-018 | Sources: B06, B07, B11 | Claim: claim_foodbev002_p18_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Low-load versus high-load stream separation

KEY

Flow volume and pollutant load must both be measured because a small high-strength stream can control treatment burden while a large low-load stream controls hydraulic capacity.

TECHNICAL BASIS

COD/BOD, solids, nutrients, salts and cleaning chemicals can be concentrated in specific process events. Mixing those streams with cooling water, condensate or later rinses dilutes concentration but not pollutant mass and can make reuse and recovery harder. Load is calculated from flow and concentration on a consistent time basis.

DECISION INTERPRETATION

Rank streams by both cubic meters and kilograms of key load per period. Separate high-load streams for product recovery, targeted treatment or controlled digestion where technically appropriate; protect low-load streams for reuse.

CONTROL ACTION

Create a flow-load matrix by source and event.

REQUIRED RECORDS

Flow; COD/TOC; BOD where used; TSS; nutrients; conductivity; pH; event duration; product-equivalent loss.

AUDIT / ESCALATION TRIGGER

Escalate projects that claim pollution reduction because concentration fell after dilution.

FOOD2-019 | Sources: B01, B10 | Claim: claim_foodbev002_p19_core
 Concentration reduction without mass-load reduction is not source control.

Treatment barrier architecture

KEY

Treatment should be selected to close the measured gap between source quality and the defined end-use requirement.

TECHNICAL BASIS

A barrier train can combine solids removal, biological treatment, membranes, adsorption, oxidation, disinfection and other steps. Multiple barriers can improve robustness when they address different failure modes, but added complexity also increases energy, maintenance, monitoring and residuals. The required log reduction or chemical target must be justified by the risk framework and jurisdiction.

DECISION INTERPRETATION

Design from the end-use target backward. Identify each hazard, the barrier responsible, performance target, monitoring surrogate, validation method and failure response. Do not add unit operations that have no defined hazard-control role.

CONTROL ACTION

Create a treatment-barrier table linked to the hazard analysis.

REQUIRED RECORDS

Hazard; barrier; design target; validated performance; critical operating parameter; monitoring alarm; diversion action.

AUDIT / ESCALATION TRIGGER

Escalate any critical hazard with no validated barrier or any barrier with no measurable operating control.

FOOD2-020 | Sources: B01, B02, B04, B05 | Claim: claim foodbev002 p20 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Filtration and solids removal

KEY

Physical pretreatment can reduce the solids burden on downstream treatment, but captured solids become a separate management requirement.

TECHNICAL BASIS

Screens, strainers, clarification, dissolved-air flotation, media filtration and cartridge/microfiltration systems address different particle sizes and loads. Solids removal can reduce turbidity, membrane fouling and disinfectant demand, but it does not necessarily remove dissolved organics, salts or pathogens.

DECISION INTERPRETATION

Select filtration from measured particle/solids characteristics and downstream requirements. Track captured-solids mass and destination; otherwise water-quality improvement can hide a residuals problem.

CONTROL ACTION

Measure influent/effluent TSS or turbidity and solids capture mass.

REQUIRED RECORDS

Particle/TSS profile; differential pressure; filtrate quality; backwash; captured-solids mass; disposal/recovery route.

AUDIT / ESCALATION TRIGGER

Escalate filtration credited with dissolved-contaminant removal that has not been demonstrated.

FOOD2-021 | Sources: B01, B06, B10 | Claim: claim foodbev002 p21 core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Membrane treatment

KEY

Membranes are selective separation barriers whose performance depends on integrity, fouling, pretreatment and contaminant properties.

TECHNICAL BASIS

Microfiltration/ultrafiltration can remove suspended solids and microorganisms to different degrees; nanofiltration/RO can reject many dissolved constituents. No membrane is a universal barrier for every chemical. Integrity and normalized performance need monitoring, and concentrate must be managed.

DECISION INTERPRETATION

Use membrane selection to target defined contaminants and end-use quality. Validate removal for critical hazards and avoid assuming conductivity removal proves removal of all organics or microorganisms.

CONTROL ACTION

Set normalized flux, pressure, conductivity and integrity alarms with independent verification.

REQUIRED RECORDS

Membrane type; pore/rejection basis; integrity test; flux; pressure; conductivity; target-contaminant validation; cleaning data.

AUDIT / ESCALATION TRIGGER

Escalate when membrane performance is inferred from vendor nominal rejection without site validation for critical contaminants.

FOOD2-022 | Sources: B01, B06, B12 | Claim: claim foodbev002 p22 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Biological treatment interfaces

KEY

Biological treatment can be effective for biodegradable organic load, but may add unnecessary complexity to comparatively clean reuse streams.

TECHNICAL BASIS

Activated sludge, anaerobic systems and other biological processes transform biodegradable organics and can support nutrient conversion, but they add biomass, retention time, variability and microbial communities. Highly saline, toxic, disinfectant-rich or nutrient-unbalanced streams may inhibit performance. A clean condensate should not be sent through biological treatment merely because it is available.

DECISION INTERPRETATION

Use biological treatment where the measured biodegradable load justifies it, and then evaluate whether the effluent requires additional polishing for the reuse target. Keep cleaner streams segregated when direct polishing is more efficient.

CONTROL ACTION

Characterize biodegradability and inhibition before adding a stream to biological treatment.

REQUIRED RECORDS

COD/BOD or respirometry; nutrients; salinity; pH; toxicants; biomass response; effluent quality; sludge production.

AUDIT / ESCALATION TRIGGER

Escalate high-strength or chemically unusual streams introduced without treatability testing.

FOOD2-023 | Sources: B01, B10 | Claim: claim_foodbev002_023_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Disinfection and microbial control

KEY

Disinfection can be a validated microbial-control barrier; it is not a substitute for solids control, chemical safety or system hygiene.

TECHNICAL BASIS

Chlorine-based systems, ozone, UV and other approaches have different effectiveness, residual behavior and by-product profiles. Turbidity, organics and hydraulic short-circuiting can reduce performance. Some systems provide no residual in storage/distribution, shifting control to hygienic design and monitoring.

DECISION INTERPRETATION

Validate dose or intensity and contact conditions against the target organisms or surrogate framework. Monitor critical operating parameters continuously where feasible and verify microbiological outcome on an appropriate schedule.

CONTROL ACTION

Link disinfection operating limits to automatic diversion and alarm response.

REQUIRED RECORDS

Disinfectant dose/residual or UV dose; flow; contact time; turbidity/UVT; microbial verification; by-product checks.

AUDIT / ESCALATION TRIGGER

Escalate disinfection systems with no validated worst-case operating condition or no response to off-spec flow/turbidity.

FOOD2-024 | Sources: B01, B02, B11 | Claim: claim_foodbev002_p24_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Chemical residuals and treatment by-products

KEY

A reuse system can create new chemical hazards through treatment even when it removes source contaminants effectively.

TECHNICAL BASIS

Disinfectants, coagulants, antiscalants, cleaning chemicals, corrosion products and oxidation by-products can remain in treated water or concentrate. WHO/FAO chemical-water work supports source- and pathway-specific prioritization rather than one universal analyte panel.

DECISION INTERPRETATION

Build a treatment-chemical inventory and evaluate residuals/by-products against the intended use. Where chemical controls rely on online surrogates, periodically verify the actual compounds of concern. Include membrane/CIP cleaning events in diversion logic.

CONTROL ACTION

Add treatment-chemical and by-product review to validation.

REQUIRED RECORDS

Chemical dose; residual; reaction by-products; cleaning schedule; corrosion indicators; analytical panel; end-use limit/basis.

AUDIT / ESCALATION TRIGGER

Escalate a microbiologically robust system with uncharacterized treatment residuals in a contact use.

FOOD2-025 | Sources: B04, B01 | Claim: claim_foodbev002_025_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Online monitoring and instrumentation

KEY

Online instruments are operational control tools only when their relationship to treatment performance is understood and maintained.

TECHNICAL BASIS

Useful parameters can include flow, pressure, turbidity, conductivity, pH, temperature, ORP, disinfectant residual, UV intensity/transmittance, TOC and other process-specific surrogates. A surrogate does not prove absence of every hazard; it indicates whether the validated process remains within its operating envelope.

DECISION INTERPRETATION

Define critical control parameters, alarm limits, calibration frequency, data retention and response. Use redundancy or independent checks where a single sensor failure could release unsuitable water.

CONTROL ACTION

Create a water-reuse instrumentation criticality register.

REQUIRED RECORDS

Sensor ID; parameter; range; calibration; alarm; interlock; data historian; verification method; spare/redundancy.

AUDIT / ESCALATION TRIGGER

Escalate any critical release decision dependent on an uncalibrated or non-interlocked sensor.

FOOD2-026 | Sources: B01, B05 | Claim: claim_foodbev002_026_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Microbiological verification

KEY

Microbiological verification provides evidence that the validated system continues to control defined hazards; it is not the same as real-time process control.

TECHNICAL BASIS

Microbial tests have sampling and analytical delay, detection limits and variability. They should verify process performance while online parameters maintain immediate control. Indicator organisms may be useful, but the selection must reflect the source, treatment and intended use.

DECISION INTERPRETATION

Use a verification plan with locations, frequency, methods, action levels, trend review and investigation rules. Include startup, post-maintenance and upset conditions where appropriate rather than sampling only steady-state water.

CONTROL ACTION

Create a microbiological verification schedule tied to risk and process change.

REQUIRED RECORDS

Sampling point; organism/indicator; method; frequency; action level; trend; corrective action; release impact.

AUDIT / ESCALATION TRIGGER

Escalate repeated marginal trends even when individual samples remain below an action level.

FOOD2-027 | Sources: B01, B02, B03 | Claim: claim_foodbev002_p27_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Chemical verification and contaminant surveillance

KEY

Chemical monitoring should be built from the source and process hazard inventory rather than from a generic universal panel.

TECHNICAL BASIS

Potential analytes include source-water contaminants, product ingredients, cleaning/sanitation chemicals, corrosion metals, treatment chemicals, persistent compounds and process-specific residues. Some hazards vary slowly and suit periodic laboratory testing; others can change quickly and require online surrogates or diversion during known events.

DECISION INTERPRETATION

Prioritize analytes by presence, potential transfer to the end use, exposure significance and treatment removal uncertainty. Record LOD/LOQ and matrix limitations. Update the panel when suppliers, chemicals, source water or treatment changes.

CONTROL ACTION

Create a risk-ranked chemical surveillance plan.

REQUIRED RECORDS

Analyte; source; route; health/product significance; treatment removal; method; LOD/LOQ; frequency; action level.

AUDIT / ESCALATION TRIGGER

Escalate when the panel excludes known plant chemicals that can enter the reuse source.

FOOD2-028 | Sources: B04, B01 | Claim: claim_foodbev002_028_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Validation, release and diversion logic

KEY

A controlled reuse system requires defined fail-safe conditions that prevent off-spec water from reaching the intended end use.

TECHNICAL BASIS

Validation establishes that the designed treatment and controls can meet the required target under defined conditions. Monitoring shows whether the system is operating within that validated envelope. Verification checks the resulting quality. Release logic connects those evidence streams to actual use, while diversion protects the process during startup, cleaning, alarm, sensor failure or off-spec results.

DECISION INTERPRETATION

Write release criteria as executable logic. Identify which deviations cause alarm, hold, retreatment, discharge or shutdown. Test the diversion system physically rather than assuming the control sequence works.

CONTROL ACTION

Commission and challenge-test all critical interlocks before production use.

REQUIRED RECORDS

Validation protocol; critical limits; PLC logic; alarm test; diversion destination/capacity; restart criteria; deviation record.

AUDIT / ESCALATION TRIGGER

Escalate any system that can continue sending reclaimed water to a high-consequence use after loss of a critical control parameter.

FOOD2-029 | Sources: B01, B05, B08, B09 | Claim: claim foodbev002 p29 core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Cross-connection and backflow prevention

KEY

Physical separation is a fundamental control because one cross-connection can bypass otherwise valid water-quality and treatment controls.

TECHNICAL BASIS

U.S. CGMP addresses backflow and cross-connections involving wastewater, and EU hygiene law requires non-potable systems to be separate and not connect with or permit reflux into potable systems. Reuse networks add complexity through multiple tanks, bypasses, hoses and temporary connections.

DECISION INTERPRETATION

Use dedicated piping, air gaps/backflow devices as applicable, clear identification, controlled hose connections and periodic physical surveys. Digital drawings do not substitute for field verification.

CONTROL ACTION

Run a cross-connection control program and annual or risk-based survey.

REQUIRED RECORDS

P&ID; line labels; backflow device test; hose map; valve lock/control; field survey; change-control record.

AUDIT / ESCALATION TRIGGER

Escalate undocumented bypasses, temporary hoses or common manifolds that can defeat water-class separation.

FOOD2-030 | Sources: B08, B09 | Claim: claim_foodbev002_030_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Storage, stagnation and distribution-loop risk

KEY

Treated water can lose quality after treatment through stagnation, biofilm growth, heat gain, residual loss, corrosion or external contamination.

TECHNICAL BASIS

Storage volume, turnover, temperature, tank hygiene, vent protection and residual disinfectant influence microbial stability. Distribution materials and dead legs can contribute corrosion or biofilms. A treatment skid outlet sample does not represent the farthest use point under all operating conditions.

DECISION INTERPRETATION

Validate the distribution system, not just the treatment train. Define maximum residence time, flushing/startup rules, tank cleaning, recirculation and representative monitoring points.

CONTROL ACTION

Map hydraulic residence time and high-risk dead legs.

REQUIRED RECORDS

Tank volume/turnover; temperature; residual; distal-point sampling; cleaning record; material compatibility; stagnation event.

AUDIT / ESCALATION TRIGGER

Escalate storage or seasonal shutdown conditions outside the validated residence-time and temperature envelope.

FOOD2-031 | Sources: B01, B11 | Claim: claim_foodbev002_031_core
 Applicability is specific to source, jurisdiction, process and evidence boundary.

Water-energy nexus

KEY

Maximum water reuse is not automatically minimum environmental or economic burden because treatment, pumping, heating and cooling consume energy.

TECHNICAL BASIS

EU food/drink/milk BAT data show material variation in specific energy and wastewater generation by subsector. Industrial reuse research also emphasizes energy trade-offs among treatment technologies. Thermal water streams can carry recoverable heat, while advanced membranes or oxidation can add electricity and chemical demand.

DECISION INTERPRETATION

Optimize combined water and energy cost/emissions. Favor source segregation, gravity, heat recovery and lower-treatment-gap loops before energy-intensive polishing of mixed wastewater where possible.

CONTROL ACTION

Add kWh per cubic meter reused and recovered thermal energy to project evaluation.

REQUIRED RECORDS

Pump energy; treatment energy; heat content; recovered heat; chemical use; avoided freshwater energy; avoided wastewater treatment.

AUDIT / ESCALATION TRIGGER

Escalate projects that report water savings without an energy and residuals balance.

FOOD2-032 | Sources: B10, B12 | Claim: claim_foodbev002_p32_core
 BAT energy ranges are subsector comparators and not universal targets.

Concentrate, reject and residual management

KEY

Reuse does not necessarily eliminate contaminants; many systems transfer a portion to concentrate, sludge, spent media, backwash or other residuals.

TECHNICAL BASIS

Membranes concentrate dissolved constituents, clarification captures solids, biological systems create biomass, and adsorption/media systems create spent material. Increasing water recovery can reduce liquid volume while increasing residual concentration and disposal difficulty.

DECISION INTERPRETATION

Build a residual mass balance into the reuse design. Verify final destination, classification and treatment. A project should not claim circularity if it merely shifts a difficult contaminant from water to an unmanaged solid or concentrate.

CONTROL ACTION

Assign an approved destination and mass accounting method to every residual stream.

REQUIRED RECORDS

Residual type; mass/volume; concentration; classification; handling; receiving facility; acceptance evidence; cost.

AUDIT / ESCALATION TRIGGER

Escalate projects whose concentrate or sludge route is undefined at design approval.

FOOD2-033 | Sources: B06, B10 | Claim: claim_foodbev002_033_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Water-reuse KPI architecture

KEY

KPIs must distinguish conservation, internal recirculation, net freshwater displacement, treated-water production, water quality and verified end use.

TECHNICAL BASIS

Recommended metrics include total water intensity, potable-water intensity, reused-water fraction, source capture fraction, treatment recovery, diversion/off-spec rate, energy per cubic meter reused, chemical consumption, residual generation and compliance/verification performance. BAT ranges can contextualize facility intensity when denominator and scope align.

DECISION INTERPRETATION

Do not inflate reuse by counting water recirculated in a closed loop multiple times. Report both gross recirculation and net freshwater displacement. Keep product water and non-contact utility water separate where the risk and quality requirements differ.

CONTROL ACTION

Adopt a KPI dictionary with numerator, denominator, exclusions, period and owner.

REQUIRED RECORDS

Flow totals; production denominator; water class; net freshwater displacement; energy; residuals; quality results; downtime.

AUDIT / ESCALATION TRIGGER

Escalate KPI changes caused by denominator or boundary changes rather than physical performance.

FOOD2-034 | Sources: B10, B01 | Claim: claim_foodbev002_p34_core
 EU BAT examples: brewery wastewater 0.15-0.50 m³/hl product; market milk 0.3-3.0 m³/t raw material; cheese 0.75-2.5; milk powder 1.2-2.7, all within the BAT scope and yearly-average basis.

Economic model and true avoided cost

KEY

Reuse economics should compare total avoided cost with total new cost, not reclaimed-water production cost with freshwater tariff alone.

TECHNICAL BASIS

Avoided costs can include purchased water, abstraction, sewer/discharge charges, pretreatment, heating/cooling, chemicals, production losses associated with water scarcity and future capacity constraints. New costs include capital, pumping, treatment, monitoring, laboratory work, maintenance, membranes/media, residual handling, downtime and regulatory work.

DECISION INTERPRETATION

Use source-end-use pathway economics. A low-treatment condensate loop may outperform an advanced mixed-wastewater reuse system even at lower absolute volume. Separate resilience value from direct operating savings rather than forcing every benefit into one payback number.

CONTROL ACTION

Build a discounted cash flow or annualized cost model with sensitivity cases.

REQUIRED RECORDS

CAPEX; OPEX; avoided water/sewer; energy; chemicals; labor; lab; residuals; production/resilience assumptions; uncertainty.

AUDIT / ESCALATION TRIGGER

Escalate reuse projects justified by water tariff alone or by unverified avoided sewer/treatment charges.

FOOD2-035 | Sources: B05, B06, B12 | Claim: claim_foodbev002_p35_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Water-reuse failure-mode matrix

KEY

Reuse systems can fail through source changes, barrier failure, monitoring failure, distribution contamination and human bypasses - not only treatment-unit breakdown.

TECHNICAL BASIS

Critical failure modes include unexpected chemical contamination, pathogen breakthrough, membrane breach, disinfectant failure, sensor drift, valve misalignment, cross-connection, tank stagnation, CIP intrusion, power loss, concentrate overflow, wrong end-use connection and incomplete startup diversion.

DECISION INTERPRETATION

Use FMEA or HACCP-style logic: identify hazard, cause, preventive control, detection method, critical limit, response and evidence of restoration. High-consequence uses need fail-safe design and clear authority to stop production or divert water.

CONTROL ACTION

Run a multidisciplinary reuse hazard review before commissioning and after major changes.

REQUIRED RECORDS

Failure mode; severity; likelihood; detection; critical control; response; test frequency; owner.

AUDIT / ESCALATION TRIGGER

Escalate any single-point failure that can release unsuitable water without detection or diversion.

FOOD2-036 | Sources: B01, B05 | Claim: claim_foodbev002_036_core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Worked fit-for-purpose reuse decision

KEY

A worked decision should show how one source can be acceptable for one end use yet unsuitable for another because legal, quality and exposure requirements differ.

TECHNICAL BASIS

Example: a stable low-TOC process condensate is characterized across normal, startup and cleaning states. Candidate uses include cooling-tower makeup, boiler-feed pretreatment and a final food-contact rinse. Cooling use may need solids, salts, corrosion and microbial controls; boiler feed adds tighter chemistry requirements; final-rinse use adds food-safety legal, microbial and chemical validation burdens.

DECISION INTERPRETATION

The decision is not to assign one "reuse quality" to the condensate. It is to compare treatment gap, legal requirement, validation burden, temporal demand, energy and residuals for each end use. The lower-consequence use may create the strongest risk-adjusted value.

CONTROL ACTION

Use this decision template for all major candidate loops.

REQUIRED RECORDS

Source profile; three candidate end uses; legal gate; treatment gap; validation plan; cost; residuals; preferred route.

AUDIT / ESCALATION TRIGGER

Escalate worked examples that imply authorization for direct-contact reuse without a specific jurisdiction and competent legal review.

FOOD2-037 | Sources: B01, B05, B08, B09 | Claim: claim foodbev002 p37 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

30/60/90-day water-loop implementation program

KEY

Implementation should begin with measurement and source segregation, then progress through validated lower-consequence loops before higher-consequence applications.

TECHNICAL BASIS

Days 1-30: map water sources/uses, close the site balance, verify meters, classify contact risk, identify state/authority requirements and rank low-load sources. Days 31-60: characterize priority streams across operating states, build hazard analyses, pilot treatment, validate sensors/diversion and model economics. Days 61-90: commission approved loops, complete verification, train operators, test cross-connections/interlocks and track KPIs.

DECISION INTERPRETATION

Prioritize high-confidence non-contact or closed-loop opportunities first unless a compelling process need justifies higher-consequence work. Build organizational capability before direct product-contact reuse.

CONTROL ACTION

Launch a phased portfolio with technical, food-safety, regulatory, utility and operations owners.

REQUIRED RECORDS

Water map; meter plan; hazard assessments; legal notes; pilot results; validation; SOPs; training; KPI dashboard.

AUDIT / ESCALATION TRIGGER

Escalate programs that count installed reuse capacity instead of verified safe freshwater displacement.

FOOD2-038 | Sources: B01, B05, B06 | Claim: claim foodbev002 p38 core
Applicability is specific to source, jurisdiction, process and evidence boundary.

Controlled source register A

KEY

The core evidence base should combine current Codex/FAO-WHO risk frameworks with controlling jurisdiction-specific law and official reuse/hygiene sources.

TECHNICAL BASIS

Register A includes CXG 100-2023, FAO/WHO microbiological and chemical assessments, EPA WRAP 2.0/industrial resources and 21 CFR 117.37.

DECISION INTERPRETATION

Use Codex for risk methodology, EPA WRAP for policy/program status, and 21 CFR for U.S. CGMP requirements. Do not substitute one evidence class for another.

CONTROL ACTION

Freeze official source locators and dates before technical review.

REQUIRED RECORDS

URL; locator; jurisdiction; version/date; supported claim IDs; reviewer.

AUDIT / ESCALATION TRIGGER

Escalate if current federal or Codex text changes materially before release.

FOOD2-039 | Sources: B01, B02, B03, B04, B05, B06, B07, B08 | Claim: claim_foodbev002_p39_source_control
Applicability is specific to source, jurisdiction, process and evidence boundary.

Controlled source register B and methodological notes

EU hygiene law, BAT conclusions, drinking-water guidance and technoeconomic evidence must remain explicitly labeled by legal status, source class and technical boundary.

B01 - Codex CXG 100-2023 - Guidelines for the Safe Use and Reuse of Water in Food Production and Processing

Class: S0. Use: Official Codex fit-for-purpose water risk framework; source, intended use, hazards, treatment, validation, monitoring and verification.

<https://www.fao.org/fao-who-codexalimentarius/codex-texts/guidelines/en/>

B02 - FAO/WHO - Safety and Quality of Water Used in Food Production and Processing, MRA 33

Class: S1. Use: Official FAO/WHO microbiological risk assessment for water used in food production and processing.

<https://openknowledge.fao.org/handle/20.500.14283/ca6062en>

B03 - FAO/WHO - Safety and quality of water use and reuse in dairy products, MRA 40

Class: S1. Use: Official dairy-specific source-treatment-end-use reuse assessment and fit-for-purpose scenarios.

<https://www.who.int/publications/i/item/9789240066588>

B04 - FAO/WHO - Prioritizing food safety issues related to chemical water quality in agrifood systems

Class: S1. Use: Official chemical-hazard prioritization, transfer and dietary-exposure framework.

<https://www.who.int/publications/i/item/9789240117105>

B05 - EPA Water Reuse Action Plan 2.0: Summer Update

Class: S1. Use: Official U.S. federal reuse-program status, permitting support, pilots, validation and decision-framework actions.

<https://www.epa.gov/waterreuse/water-reuse-action-plan-20-summer-update>

B06 - EPA Water Reuse for Industrial Applications Resources

Class: S1. Use: Official EPA industrial-reuse resource hub, including food/beverage and treatment-context resources.

<https://www.epa.gov/waterreuse/water-reuse-industrial-applications-resources>

B07 - EPA REUSExplorer

Class: S1. Use: Official EPA state regulation/guideline research aid; not a substitute for current state law, regulation or permit conditions.

<https://www.epa.gov/waterreuse/regulations-and-end-use-specifications-explorer-reuseexplorer>

B08 - 21 CFR 117.37 - Sanitary facilities and controls

Class: S0. Use: Binding U.S. CGMP requirements for water safety/adequate sanitary quality and wastewater backflow/cross-connection control.

<https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-117/subpart-B/section-117.37>

B09 - Regulation (EC) No 852/2004 - Hygiene of foodstuffs (current consolidated text)

Class: S0. Use: Binding EU food-hygiene requirements for potable/non-potable systems and recycled water in processing or as an ingredient.

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02004R0852-20210324>

B10 - Commission Implementing Decision (EU) 2019/2031 - Food, Drink and Milk BAT conclusions

Class: S0. Use: Official EU BAT conclusions, including indicative resource-performance levels and direct-discharge BAT-AELs within stated scope.

https://eur-lex.europa.eu/eli/dec_impl/2019/2031/oj/eng

B11 - WHO Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda

Class: S2. Use: WHO drinking-water hazard/risk-management guidance where potable quality is the relevant end-use benchmark.

<https://www.who.int/publications/i/item/9789240045064>

B12 - Lawrence Berkeley National Laboratory - Opportunities and Challenges for Industrial Water Treatment and Reuse

Class: S2. Use: National-laboratory technoeconomic evidence on industrial reuse treatment, cost and electricity trade-offs.

<https://seta.lbl.gov/publications/opportunities-and-challenges>

B13 - EPA Water Reuse and Recycling portal

Class: S1. Use: Official current U.S. federal reuse-program status and links to microbial-treatment-target resources.

<https://www.epa.gov/waterreuse>

B14 - FSIS Sanitation Performance Standards Compliance Guide - 416.2(g)

Class: S1. Use: Official agency compliance guidance for meat/poultry water-supply and reuse context; not a substitute for controlling CFR text.

<https://www.fsis.usda.gov/inspection/compliance-guidance/sanitation-performance-standards-compliance-guide>

METHODOLOGICAL NOTES

- Fit-for-purpose is authorization-gated: treatment performance alone never authorizes a reuse application; end use, jurisdiction and food-safety requirements remain explicit gates.
- Microbial and chemical safety are separate. Microbiological validation does not establish chemical suitability; the chemical panel must follow source, process and treatment hazards.
- EU BAT water and energy values retain their original denominators, applicability and yearly-average basis; they are comparative evidence, not universal limits.
- Net freshwater displacement is distinguished from gross recirculation so closed-loop circulation is not counted repeatedly as freshwater savings.

- Release/diversion is part of treatment control. Off-spec conditions require defined hold, diversion, retreatment, discharge or shutdown logic.
- State-specific U.S. claims require current state authority. EPA REUSExplorer is a research aid, not a substitute for controlling state law or permit conditions.
- Source class and legal status are independent: an authoritative guidance document can be high-quality evidence without itself creating legal authorization.
- Source B11 has been updated to WHO's fourth edition incorporating the first and second addenda (2022), replacing the superseded first-addendum-only edition.