Postharvest Water Session

SRIPS Conference 2024

Session Roadmap

Part 1	Overview of Harvest and Postharvest Water PSR Requirements
Part 2	Challenges of Managing Postharvest Wash Water
Part 3	Scenario Discussion

Committee:

Michelle Danyluk, Andrea Riley, Elena Rogers, Chip Simmons, Laura Strawn, Lynette Johnston

Overview of Harvest and Postharvest Water Requirements

21 CFR 112
Subpart E

Current PSR Agricultural Water Requirements

- Subpart E (Agricultural Water) is currently under revision by the FDA.
- Preharvest agricultural water requirements remains on hold.
- FDA announced that sections related to Harvest and Postharvest Agricultural Water of Subpart E went into effect January 2023.

Harvest and Postharvest Agricultural Water Compliance Dates

Farm Size	Date
Large (>$500K)	1/26/2023
Small ($250K to $500K)	1/26/2024
Very Small ($25K to $250K)	1/26/2025

What is Agricultural Water?

Water used in covered activities on covered produce that is intended to, or is likely to, contact covered produce or food contact surfaces.

Preharvest Ag Water

Water used during growing activities.

- Irrigation water
- Crop sprays
- Frost protection

} Direct application

Harvest and Postharvest Ag Water

Water used in harvesting, packing, and holding activities.

Examples of Harvest and Postharvest Water

Photo: Southwest VA Farmers' Market

More examples…

Photo: Produce Safety Alliance

Harvest and Postharvest Agricultural Water Requirements: 21 CFR Part 112

Subpart E

112.41: Quality standard

112.42: Inspections and maintenance

112.43: Treatment

112.44(a): Microbial quality criterion

112.45(a): Measures

112.46(a,c): Testing

112.47: Who may test

112.48: Additional management and monitoring

112.50: Records

Subpart N

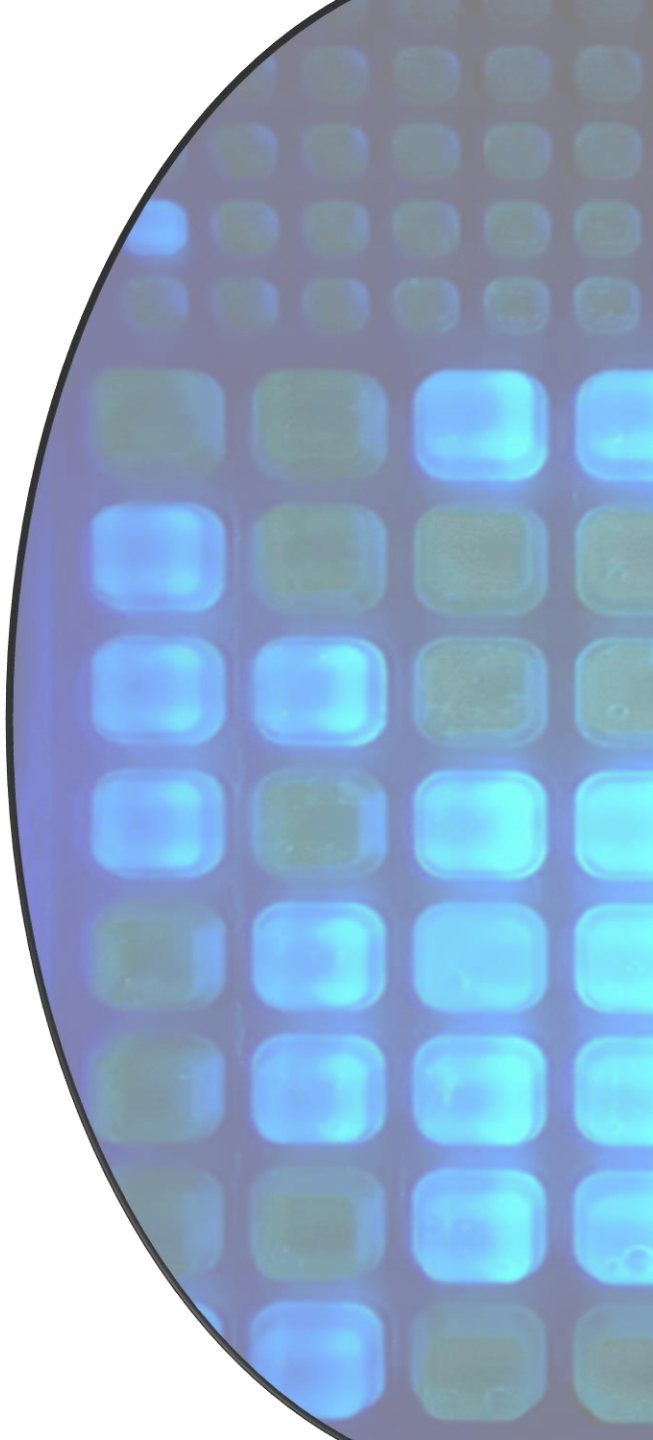
112.151: Test methods

Subpart O

112:161: Record requirements

Microbial Water Quality Criteria for Harvest and Postharvest Water

- Must be safe and of adequate sanitary quality for its intended use
- No detectable generic *E. coli* in 100 mL of water
  - Must maintain safe and adequate sanitary quality throughout use
- Cannot be sourced from untreated surface water



Harvest and Postharvest Agricultural Water Testing Requirements

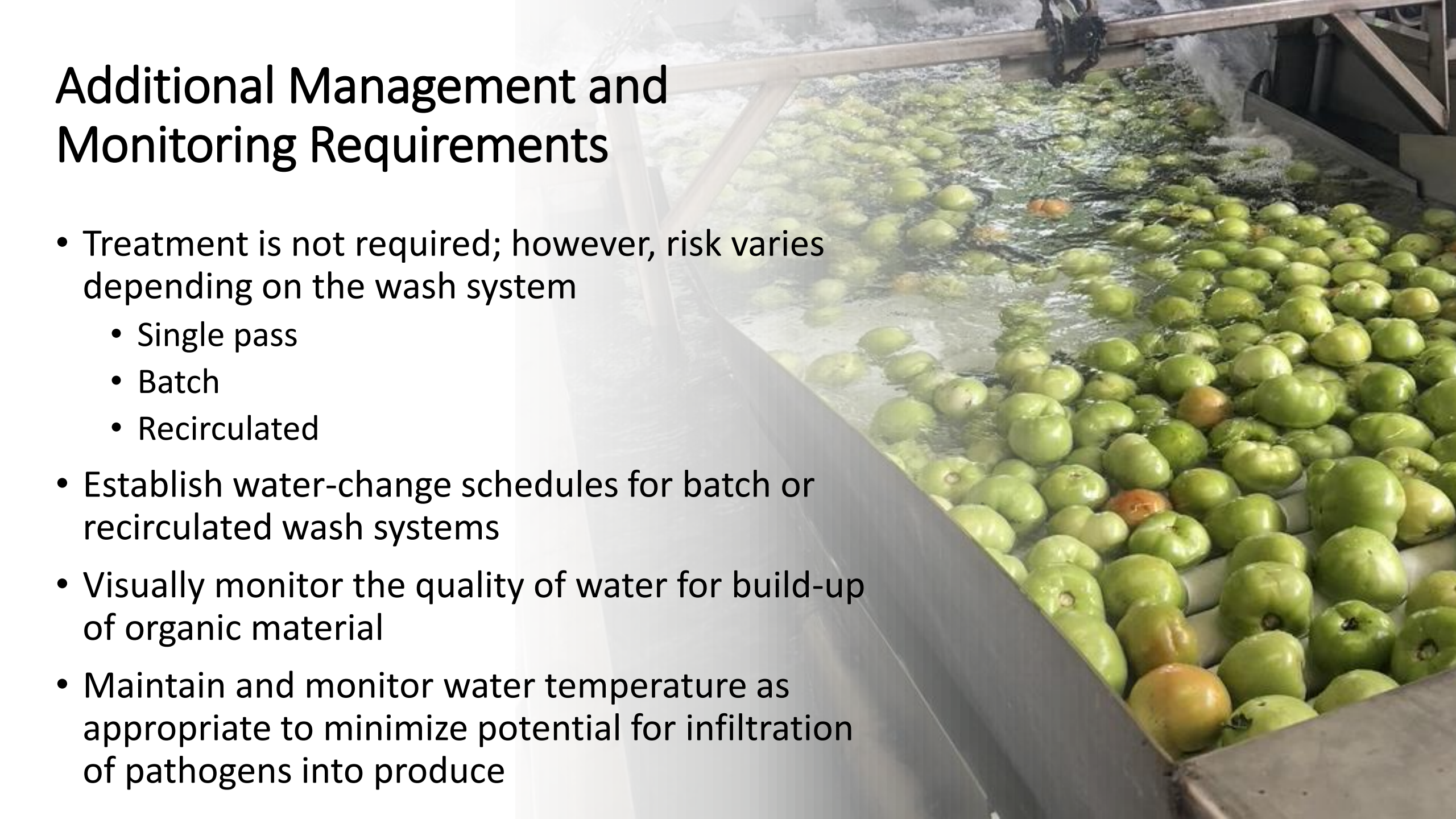
Public Water System/Supply	Ground Water	Surface Water
• Testing is not required • Results or certificates of compliance collected annually	• Initially, each source must be tested 4x during the growing season or over a period of a year • Once a year thereafter • If a test fails, resume testing 4x during the growing season or year • Records required	• Not allowed for use, unless treated • Must ensure treatment is effective • Records required

Harvest and Postharvest Water Treatment

- If used:
  - Treatment must be effective and delivered to ensure the water is consistently safe and of adequate sanitary quality for its intended use and/or meets microbial standard
  - Treatment may be physical, chemical or a combination
  - Treatment must be monitored according to the label instructions
  - Records are required

Additional Management and Monitoring Requirements

- Treatment is not required; however, risk varies depending on the wash system
  - Single pass
  - Batch
  - Recirculated
- Establish water-change schedules for batch or recirculated wash systems
- Visually monitor the quality of water for build-up of organic material
- Maintain and monitor water temperature as appropriate to minimize potential for infiltration of pathogens into produce



Water System Inspections and Maintenance

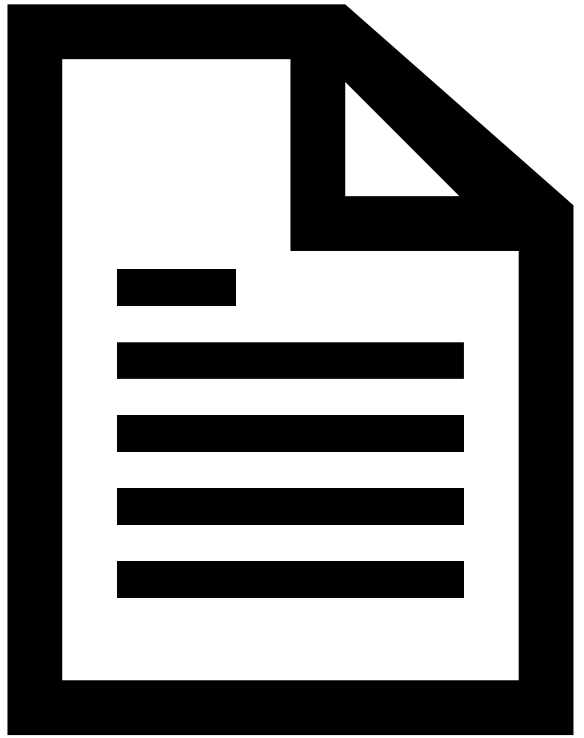
- Must inspect the source of water and its distribution systems at least annually and correct conditions that can introduce hazards
- Must conduct maintenance as needed based on the findings of the water system inspections
- Keep the source free of debris, trash, domesticated animals, and other possible sources of contamination.
- Correct any significant deficiencies (e.g., repairs to well cap, well casing, sanitary seals, piping tanks and treatment equipment, and control of cross-connections)

Corrective Measures

- Must immediately discontinue using water if at any time it does not meet water quality standards or is no longer safe
- In order to resume use, must:
  - Re-inspect the system and make changes as needed, or
  - Treat the water according to treatment requirements.
- Records are required

Records

- Water testing results
- Documentation from public water systems
- Water system inspection findings
- Documentation of corrective actions taken
- Documentation of adequate treatment methods (if using)
- Treatment monitoring logs



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Part 2

Challenges of Managing Postharvest Wash Water

Dr. Laura K Strawn
Virginia Tech
SRIPs Meeting 2024

Kudos to my Southern Center Friends

BIG THANK YOU

- Keith Schneider
- Faith Critzer
- Michelle Danyluk

So what's the big deal?

- Water facilitates microbial transfer from contaminated produce to non-contaminated produce
  - Foodborne pathogens will go unnoticed
  - Decay organisms (molds, yeast, bacteria) will decrease shelf-life and will also be spread
    - A lot of times this resonates much better with growers, so sell the double benefit of managing postharvest washing appropriately
- Washing does not alleviate preharvest contamination risk
  - Adding a sanitizer, along with management of critical parameters to wash water, reduces risk from potential cross-contamination

Postharvest water is NOT used for…

- Postharvest water is not a kill step
- It will not un-adulterate contaminated product
- It is not to be used in lieu of GAPs

To wash or not to wash, that is the question…

Do growers have to wash produce?

- The FSMA Produce Safety Rule does not require growers or packers to wash produce

- Washing, even with a sanitizer, does not disinfect produce but may benefit aesthetics and shelf life

Why some growers will wash

- Buyer or other industry requirements
- Washing produce is purely for aesthetics or quality
  - Removes soil, clean surface
  - Rapidly cool produce to maintain quality
- If you must wash, **how can we minimize food safety risks?**

Risk Profiling Harvest/Postharvest Systems

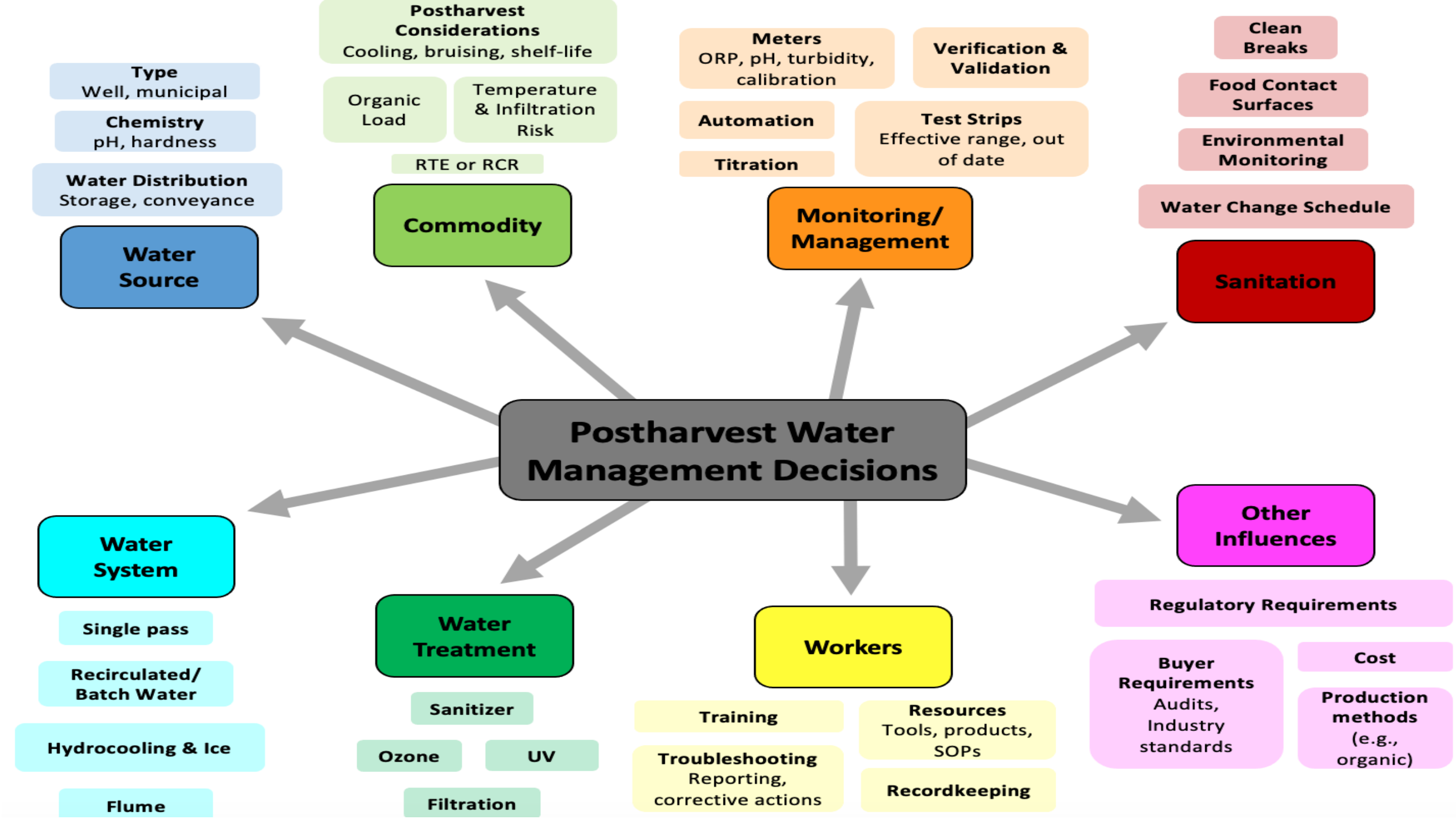
- If you want to move the needle… let's talk management











Postharvest Water Management Decisions
Water Source
Type
Well, municipal
Chemistry
pH, hardness
Water Distribution
Storage, conveyance
Commodity
Postharvest Considerations
Cooling, bruising, shelf-life
Organic Load
Temperature & Infiltration Risk
RTE or RCR
Monitoring/ Management
Meters
ORP, pH, turbidity, calibration
Verification & Validation
Automation
Test Strips
Effective range, out of date
Titration
Sanitation
Clean Breaks
Food Contact Surfaces
Environmental Monitoring
Water Change Schedule
Water System
Single pass
Recirculated/ Batch Water
Hydrocooling & Ice
Flume
Water Treatment
Sanitizer
Ozone
UV
Filtration
Workers
Training
Troubleshooting
Reporting, corrective actions
Resources
Tools, products, SOPs
Recordkeeping
Other Influences
Regulatory Requirements
Buyer Requirements
Audits, Industry standards
Cost
Production methods
(e.g., organic)

Risk Profiling Harvest/Postharvest Systems

- If you want to move the needle… let's talk management







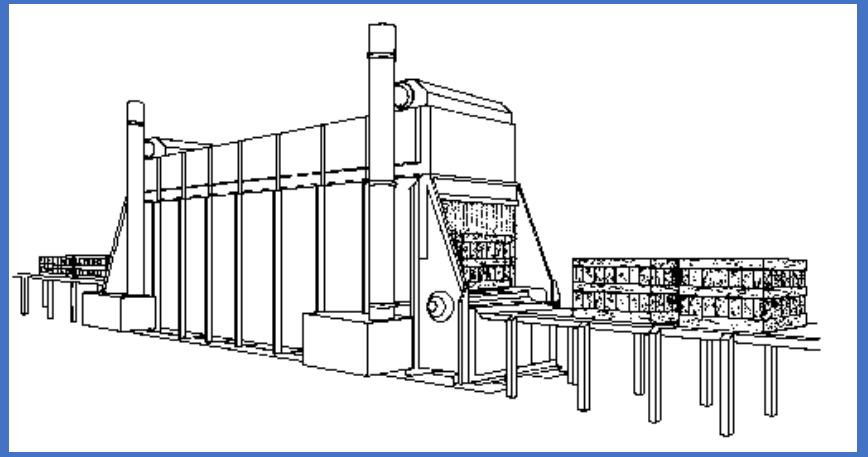


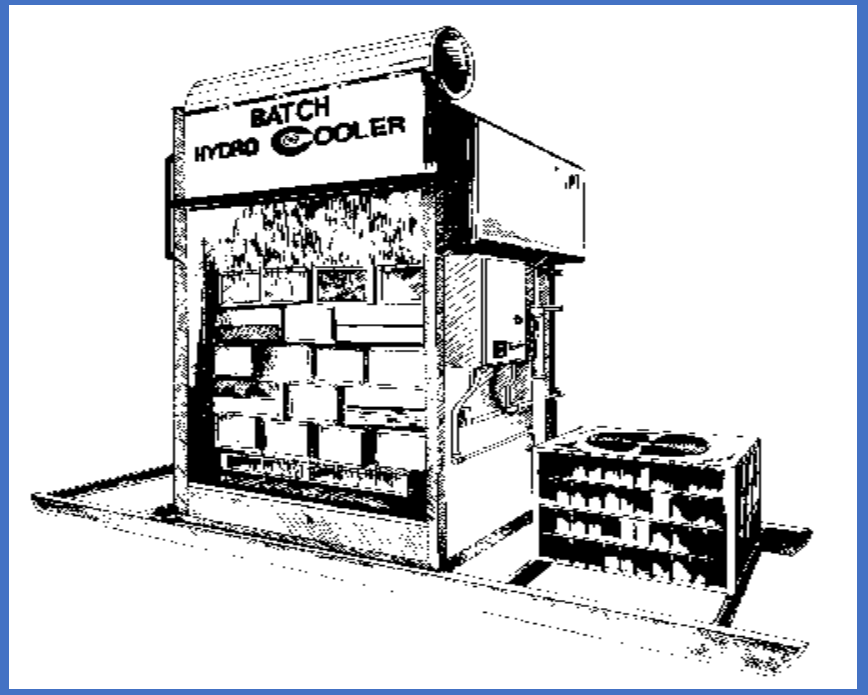

Batch, Recirculated, and Single-pass

Batch	Small volumes	Tub with water
Recirculated	Larger volumes	Flume
Single-pass	One time through the system	Spray bars

Hydrocoolers

- Basics
  - Helps to prolong shelf-life and maintain quality
  - Equipment and water sanitation critical
  - May result in pooling water
- Several Types
  - Conventional, batch, vacuum, immersion, truck/mobile
  - Can we recirculated, single pass, etc.





Ice Ice Baby

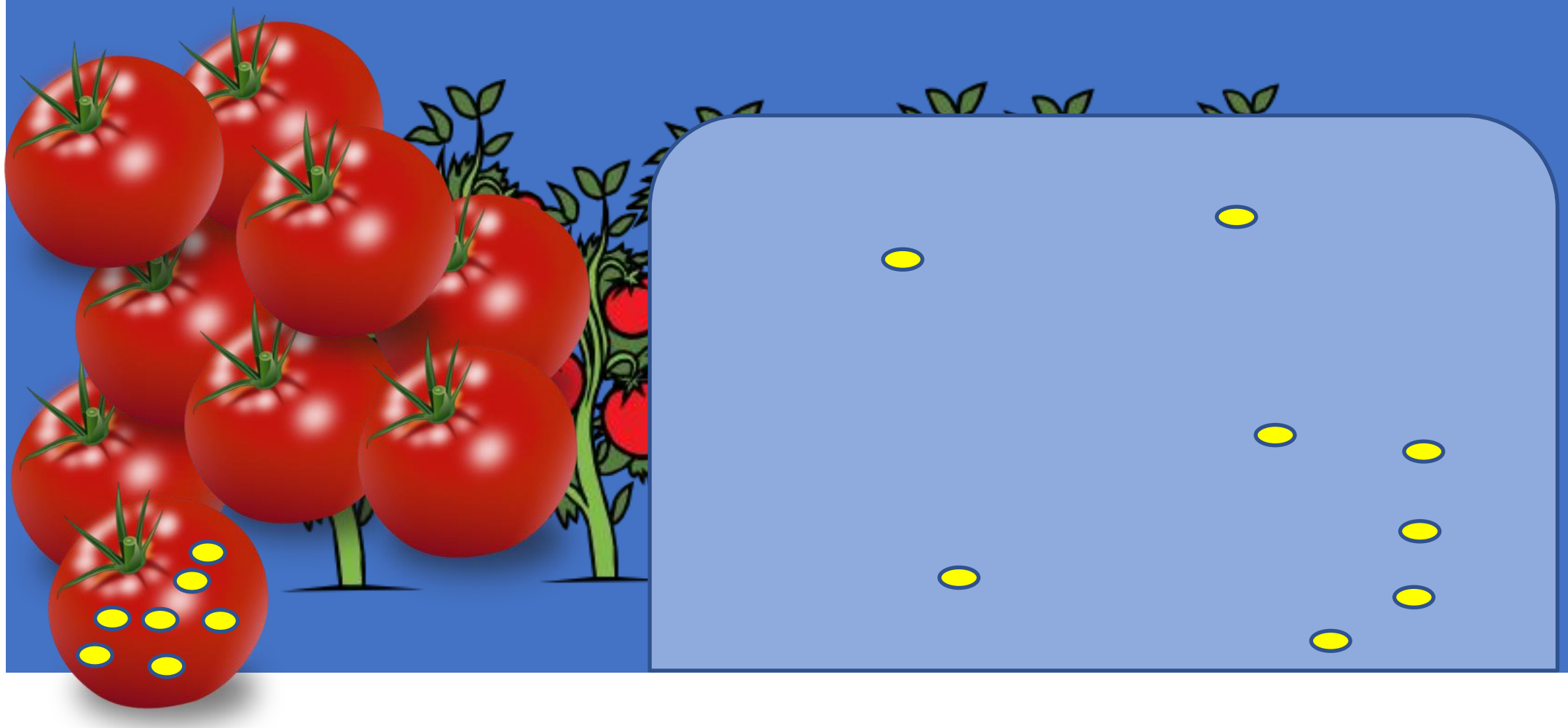
- Top ice & liquid-ice injecting
  - Minimize cross-contamination from melting ice / melting
  - May result in pooling water
  - Starting water quality
- Ice makers & storage
  - Sanitation key, starting water quality

Managing Risks with Washing

- Don’t wash
- Consider field-packing
- Consider dry-packing
- Consider cooling without dunking (e.g., single pass)

- If recirculated or batch systems are needed/used…
  - Consider a sanitizer (Science tells you “**Must Use a Sanitizer**”)
  - Consider water change schedule to reduce organic matter
  - Develop a plan to prevent organic matter build-up (e.g., culling, sorting, debris removal, clean bins if submerging, pre-wash commodities, filtration systems)

When washing a sanitizer's job is to stop cross-contamination



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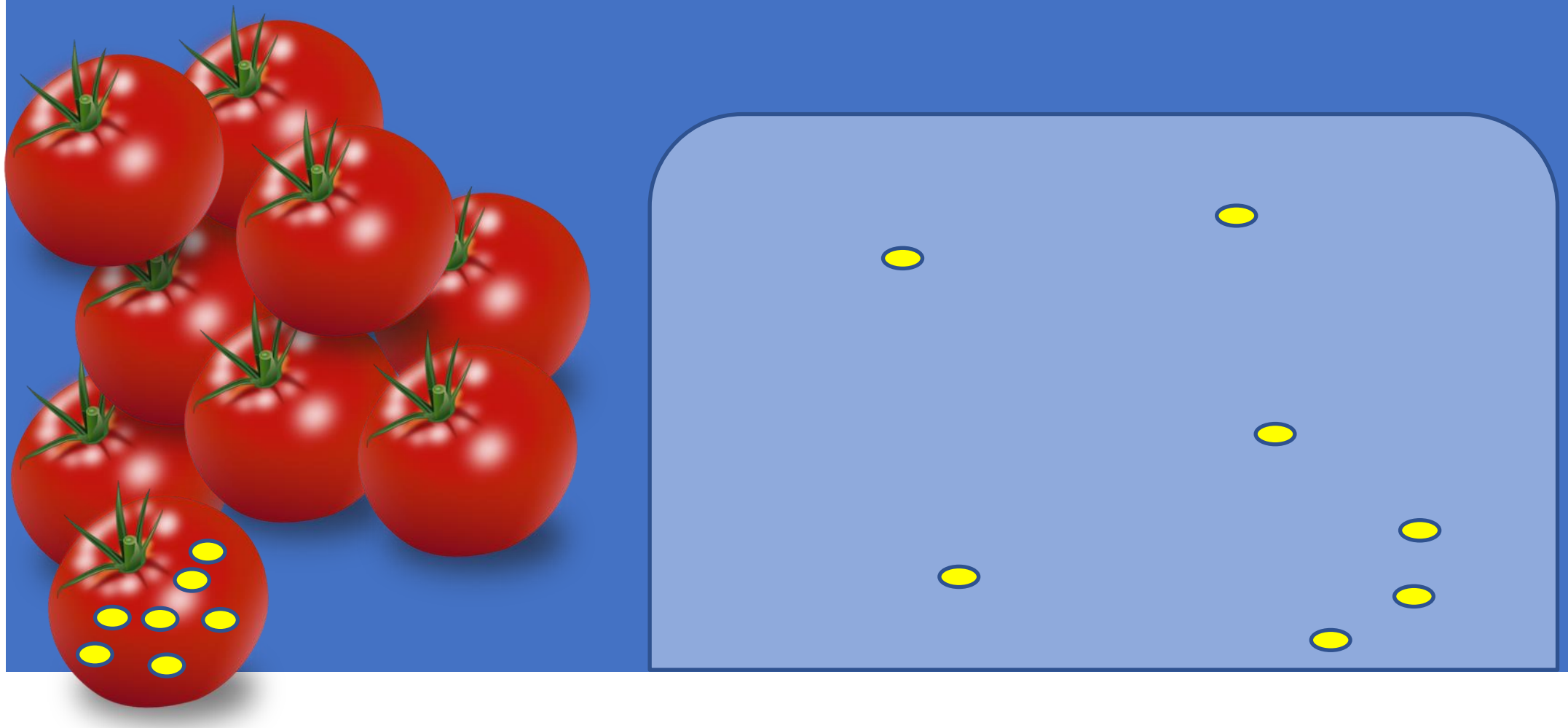


Postharvest Washing - Data

- If not properly controlled, a single mistake can impact everything processed

	Salmonella transfer onto tomatoes from one contamination event	*Salmonella* remaining in wash water
Water Only	218,776 per g of tomato	4,365,158 per mL of water
150 ppm Free Chlorine	<10 per g of tomato (none detected)	<1 in 10 mL of water (none detected)

Dunn et al., 2019

So, sanitizers will reduce my risk for cross-contamination!

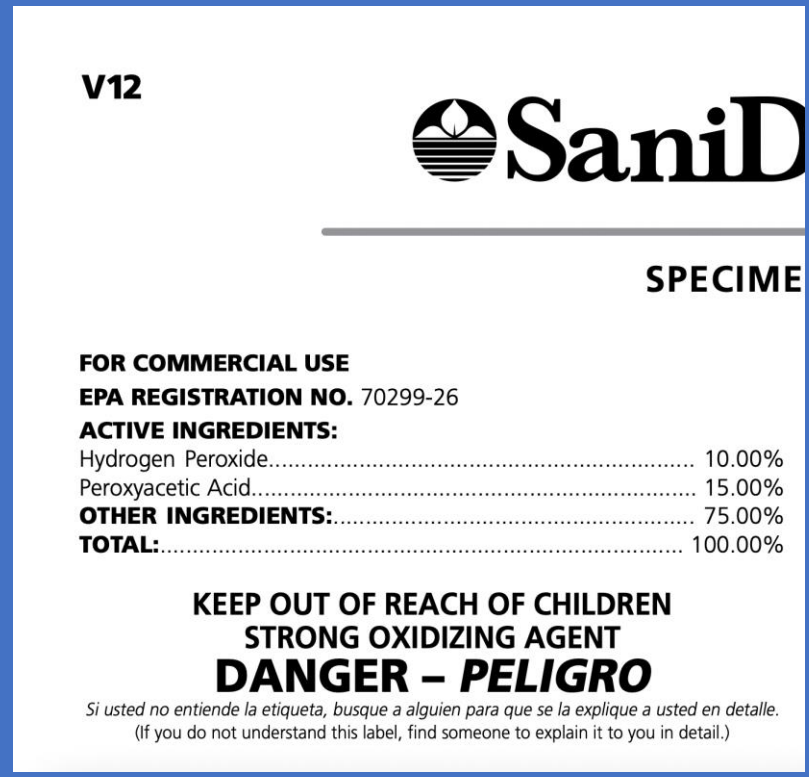
- Yes, if used correctly
- Selection and application of sanitizers can be tricky!
    - How the sanitizer is going to be used matters a lot
    - What crop is being packed?
    - How is the water being applied?
    - Will the water be recirculated?
    - How long is the water used before it is replaced?
    - Organic, economics, etc.

Common Sanitizers Used

- Hypochlorites
- Chlorine Dioxide
- Peracetic Acid
- Ozone
- Ultraviolet Light (UV)
- Others

Chemical Sanitizer Regulations

- Approval as Sanitizer
  - Environmental Protection Agency
    - EPA label showing approval for washing fruits and vegetables
    - Look for appropriate concentration and minimum contact time, is a rinse needed?


V12

SaniD

SPECIME

FOR COMMERCIAL USE

EPA REGISTRATION NO. 70299-26

ACTIVE INGREDIENTS:

Hydrogen Peroxide..... 10.00%

Peroxyacetic Acid..... 15.00%

OTHER INGREDIENTS:..... 75.00%

TOTAL:..... 100.00%

KEEP OUT OF REACH OF CHILDREN

STRONG OXIDIZING AGENT

DANGER – *PELIGRO*

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.

(If you do not understand this label, find someone to explain it to you in detail.)

*Non-chemical like UV are devices (handled differently)

Let’s Use Chlorine as a Sanitizer for Managing Wash Water

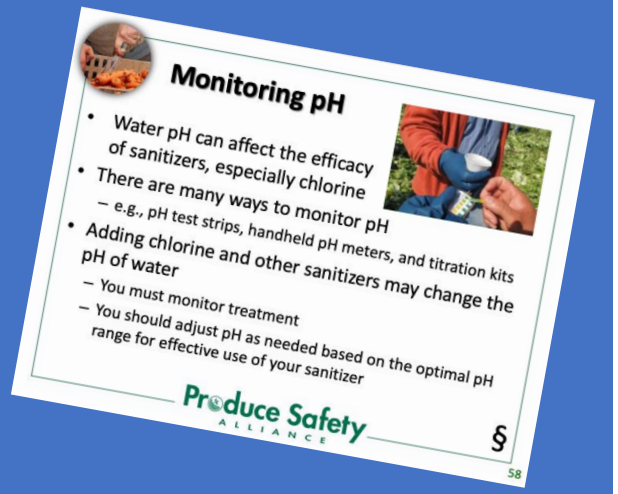
Hypochlorite (Chlorine)

- Sodium (liquid)
- Calcium (powder or tablet)

Factors Affecting Chlorine Efficacy

- Water pH
- Chlorine concentration
- Contact time
- Organic matter in the water
- Water temperature

Water pH



- Hypochlorites and Cl_2 form hypochlorous acid (HOCl) when introduced into water
- Hypochlorous acid is the chemical agent that is responsible for killing the pathogens

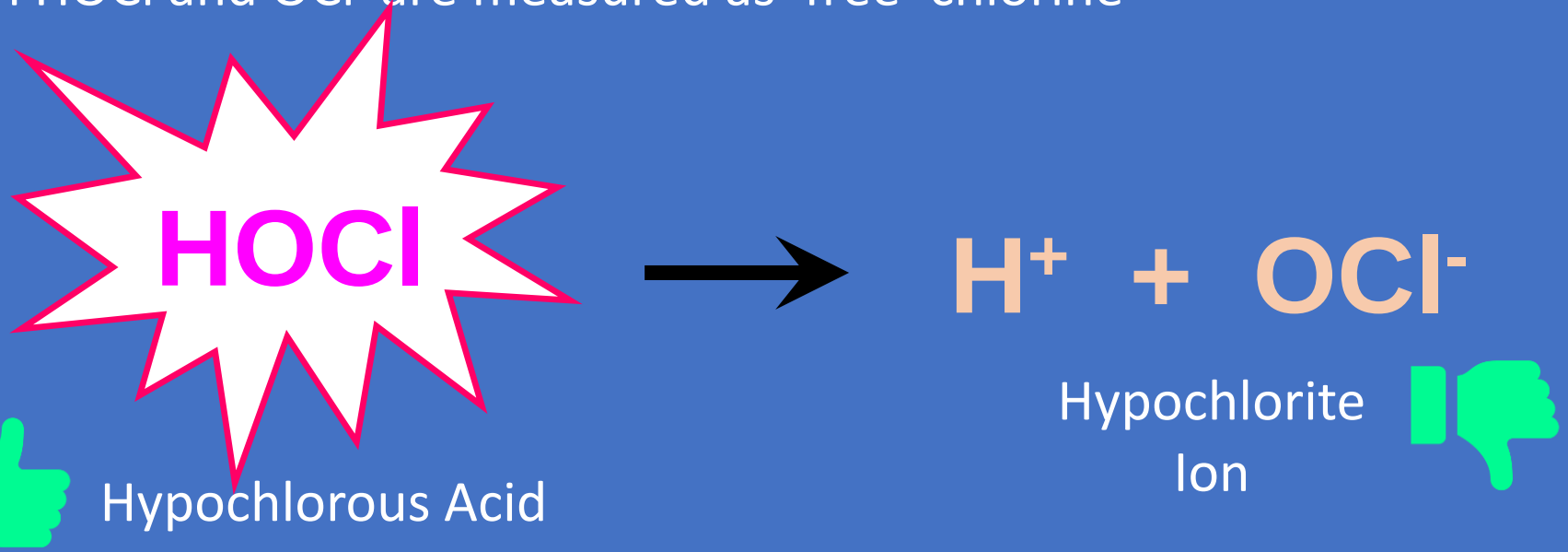
$NaOCl$
$Ca(OCl)_2$
Cl_2

(H_2O) →

HOCl

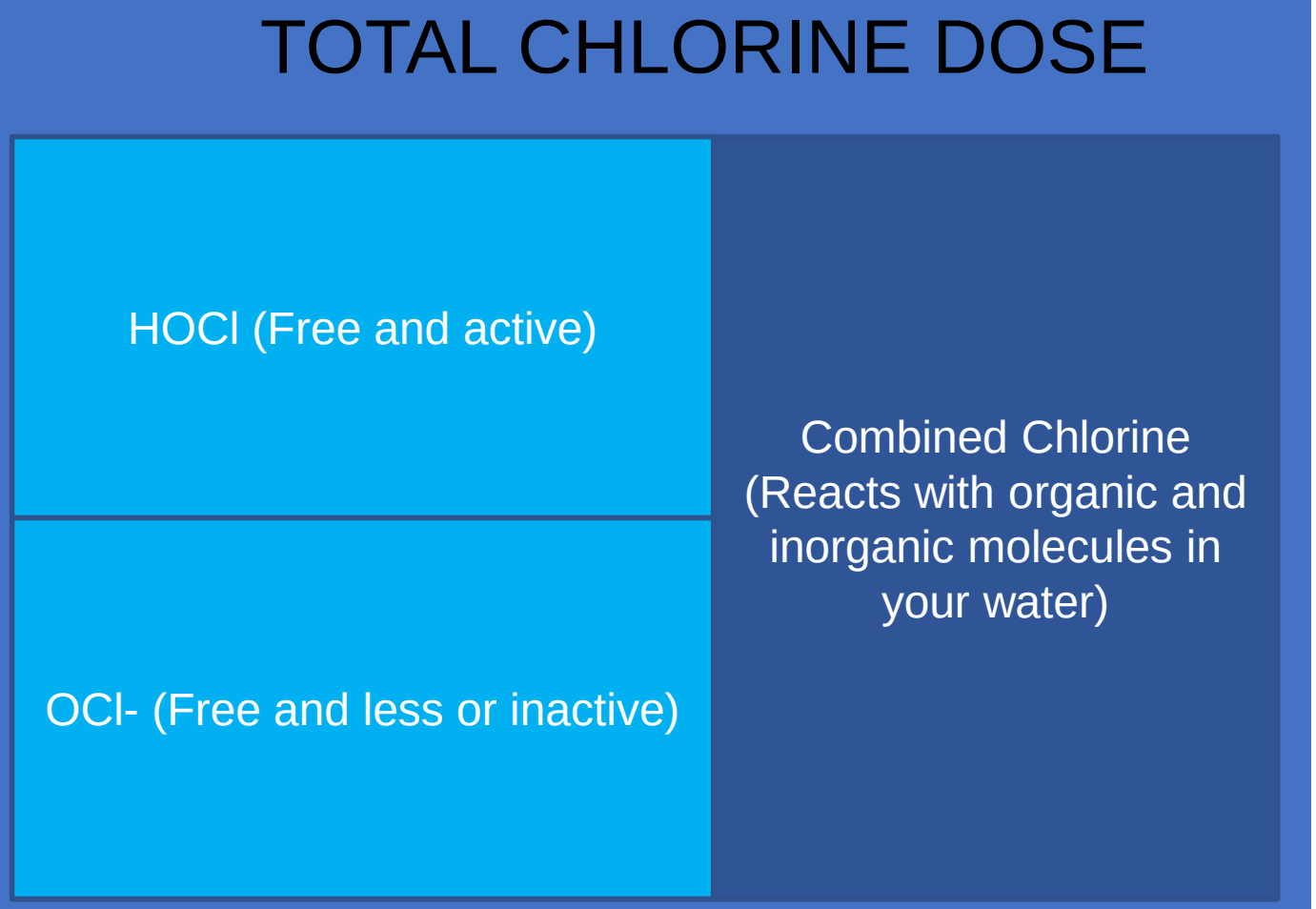
How pH affects efficacy of hypochlorite

- At high pH, hypochlorous acid (HOCl) converts to hypochlorite ion (OCl-)
  - Hypochlorite ion is relatively ineffective against pathogens
  - Both HOCl and OCl^- are measured as ‘free’ chlorine



Free vs. Total Chlorine

- Since free chlorine gives us the antimicrobial power, that is what we always monitor
  - Sometimes referred to as available chlorine
- However, free chlorine must be in the correct form
  - Influenced by pH of the water



Why this is important

- Sodium hydroxide (NaOH) is a base
- This means the more NaOCl you add, the base will be produced and the higher the pH will go and the less effective the chemistry becomes
- This why you **HAVE TO** use an acidifying agent (citric acid, phosphoric acid) to counteract the formation of NaOH
- Sweet spot is pH 6-7

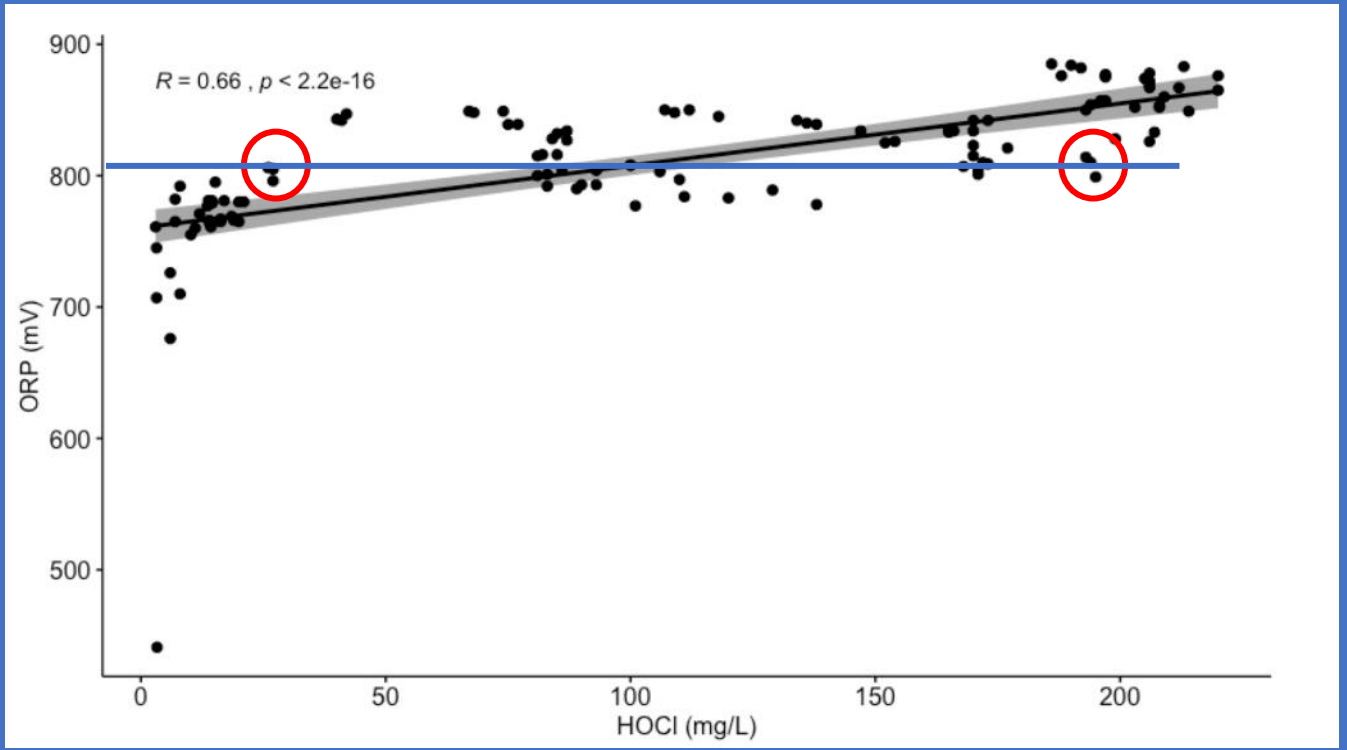
$$NaOCl + H_2O \longrightarrow HOCl + NaOH$$

Chlorine Concentration

- Relatively low chlorine concentrations can kill pathogens
- Higher concentrations are commonly used to compensate for various losses (e.g., organic matter)
- **Recirculating system may need _____ concentrations compared to single pass water systems?**

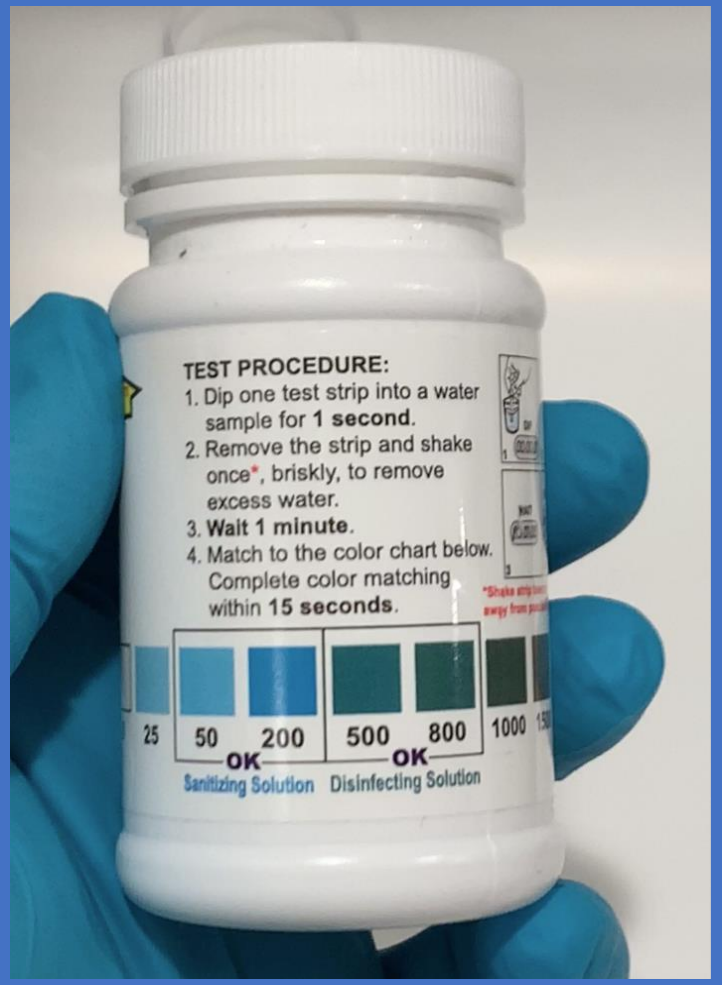
Free Chlorine vs. ORP

- While ORP can be used effectively to automate chlorine dosing within a flume system, it does not accurately predict free chlorine levels, especially at high chlorine doses and organic matter levels.



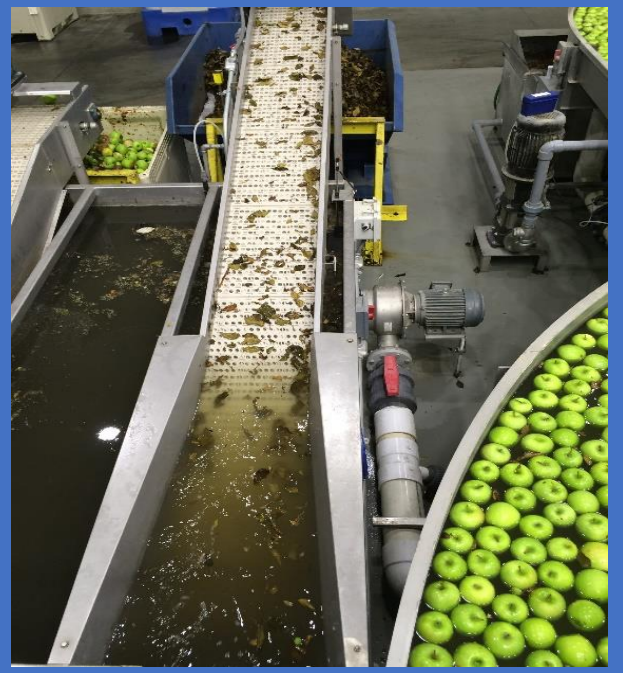
Practical Applications

- Monitoring
  - Test strips
  - Free Chlorine
  - pH
- Correct range, within date, storage, etc.



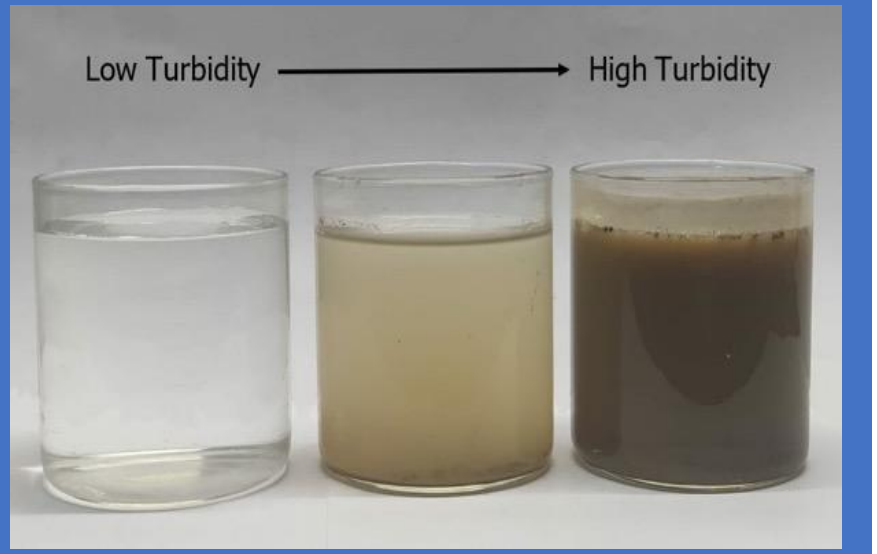
Organic Matter in the Water

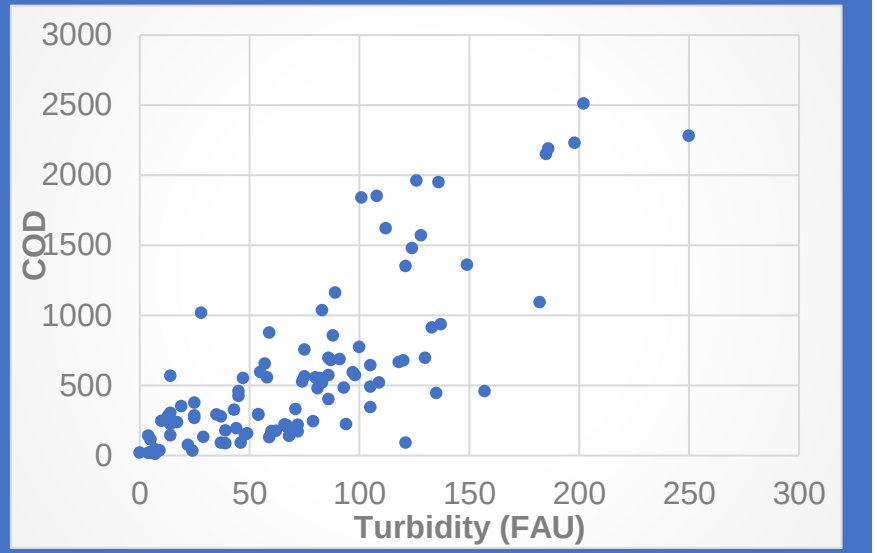
- Organic matter reacts with chlorine and quickly reduces the amount of chlorine available to kill pathogens
  - However, this chlorine may still be measured by total chlorine testing kits
  - Some sanitizers are more effective at buffering organic loads
    - Like PAA



Turbidity

- Turbidity can be used as a measure of water quality
- The higher the turbidity, the lower the potential quality, or to state in a different way the higher the demand for sanitizer
- Other tests can be used (e.g., chemical oxygen demand or COD), but turbidity is quick and easy
- As quality drops or demand increases, the amount of sanitizer needed to maintain water quality also increases





Management of Organic Build-Up

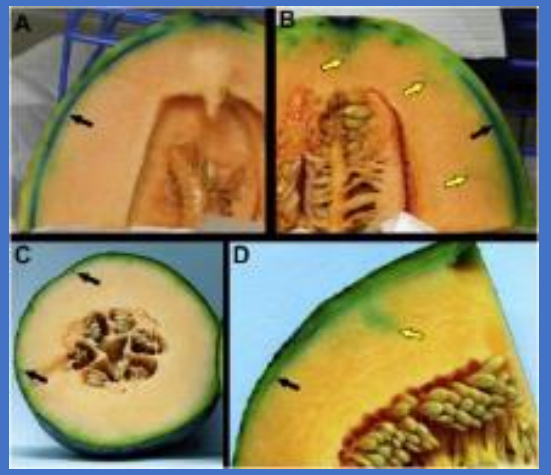
- Culling, sorting, air pressure to remove leaf material
- Clean bins, if submerging into flume water
- Pre-wash commodities prior to entry into flume/tank, especially if equipment is hard to clean
- Install filtration system or self-cleaning screens at pump intake

Water Temperature

- Water temperature can affect the efficacy of a sanitizer
  - Cooler water can slow chemical reactions, but hot water can cause chemicals to break down faster
- Temperature differential can lead to infiltration of surface contaminates
  - Hot produce immersed in cold water, organisms on the surface can be drawn into the produce, this is called **infiltration**

Temperature and Infiltration

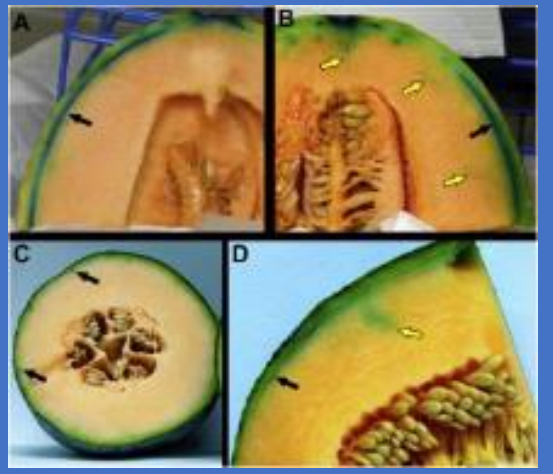
- Factors affecting infiltration risk:
  - Commodity
  - Temperature differential
  - Depth of water
  - Produce damage and stem scars
  - Time produce spends in water
  - Maturity of produce
  - Fruit hydration/dehydration



Management of Infiltration

- Avoid harvesting produce during heat of day
- Pre-cool susceptible produce using other methods, such as forced air cooling or single-pass spray
- Avoid deep tanks and overloading produce
- Minimize time produce spends in water
- Use a sanitizer in wash water to prevent cross-contamination

- FSMA PSR does have requirements for temperature management, see § 112.48(c)



Apply a Systems Approach

Washing produce isn't mandatory

- Dry packing
- Field packing

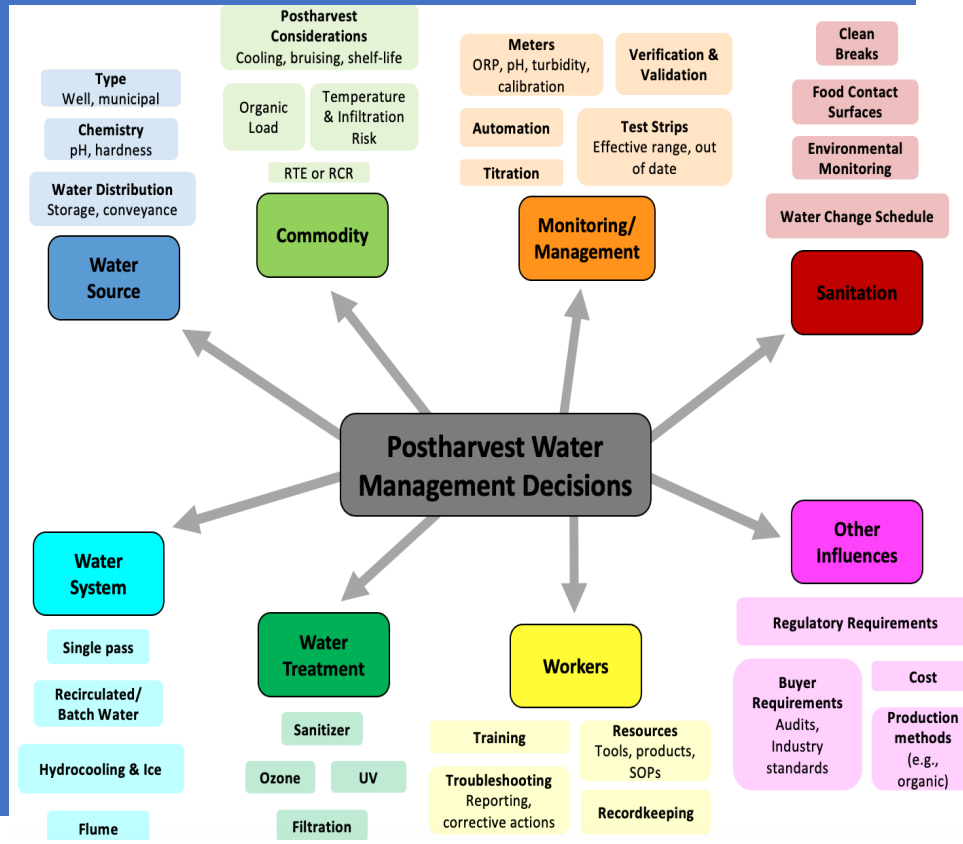
Take Home

Consider reducing time produce is in contact with the water

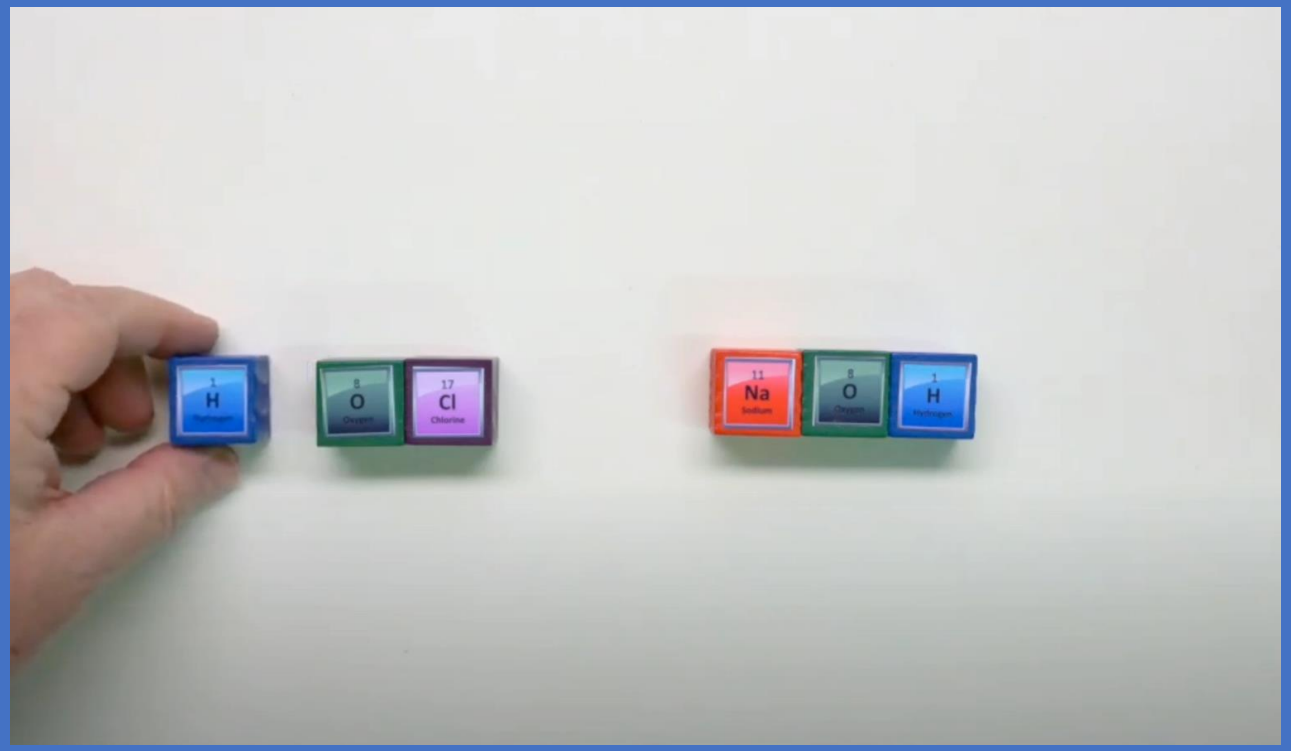
- Spray tables/bars
- Avoid dunking/submerging

Science supports <u>using sanitizers in all systems</u> of harvest/postharvest water

- Single pass systems ~ reduce biofilms
- Batch/recirculated systems ~ reduce cross-contamination



For information check out these videos on YouTube: **Produce Safety Science**



There are three videos (basic chemistry, pH effects, and why more isn't better)

They can be found at:

- https://www.youtube.com/channel/UCY2J9s4mOfKwSianlO4ELRg/videos (CONTACT)
- https://www.youtube.com/channel/UCjOO5pizX4--ds4q0RTw2ug (KRS_UF)

Thank you & Questions?

Session Roadmap

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Part 2 Challenges of Managing Postharvest Wash Water

Part 3 Scenario Discussion

Committee:

Michelle Danyluk, Andrea Riley, Elena Rogers, Chip Simmons, Laura Strawn, Lynette Johnston

Part 3

Part 3: Postharvest Water Discussion

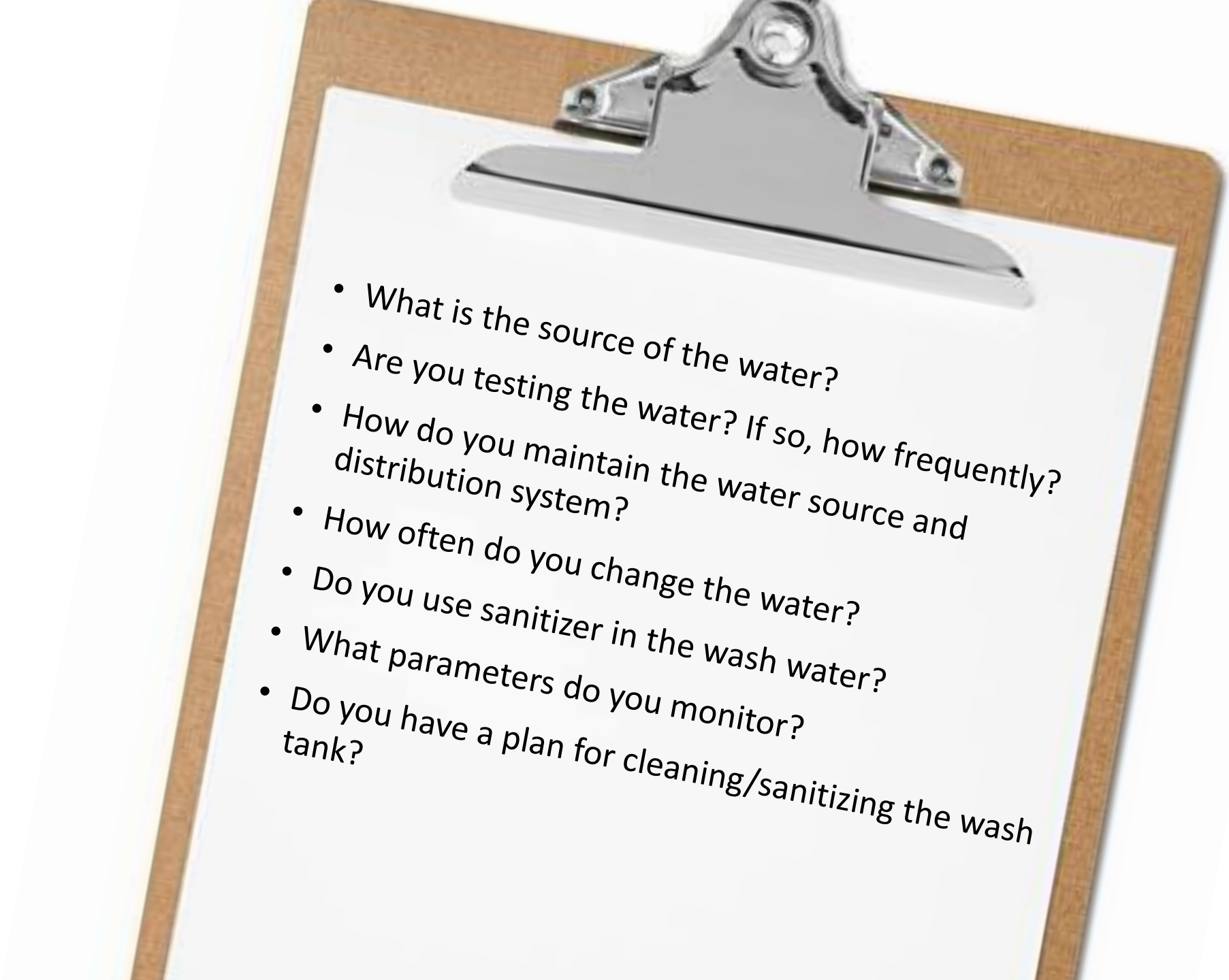
As partners in educating growers about the Produce Safety Rule, an extension employee and a state regulator are conducting an On-Farm Readiness Review on a local farm.

Initial Assessment

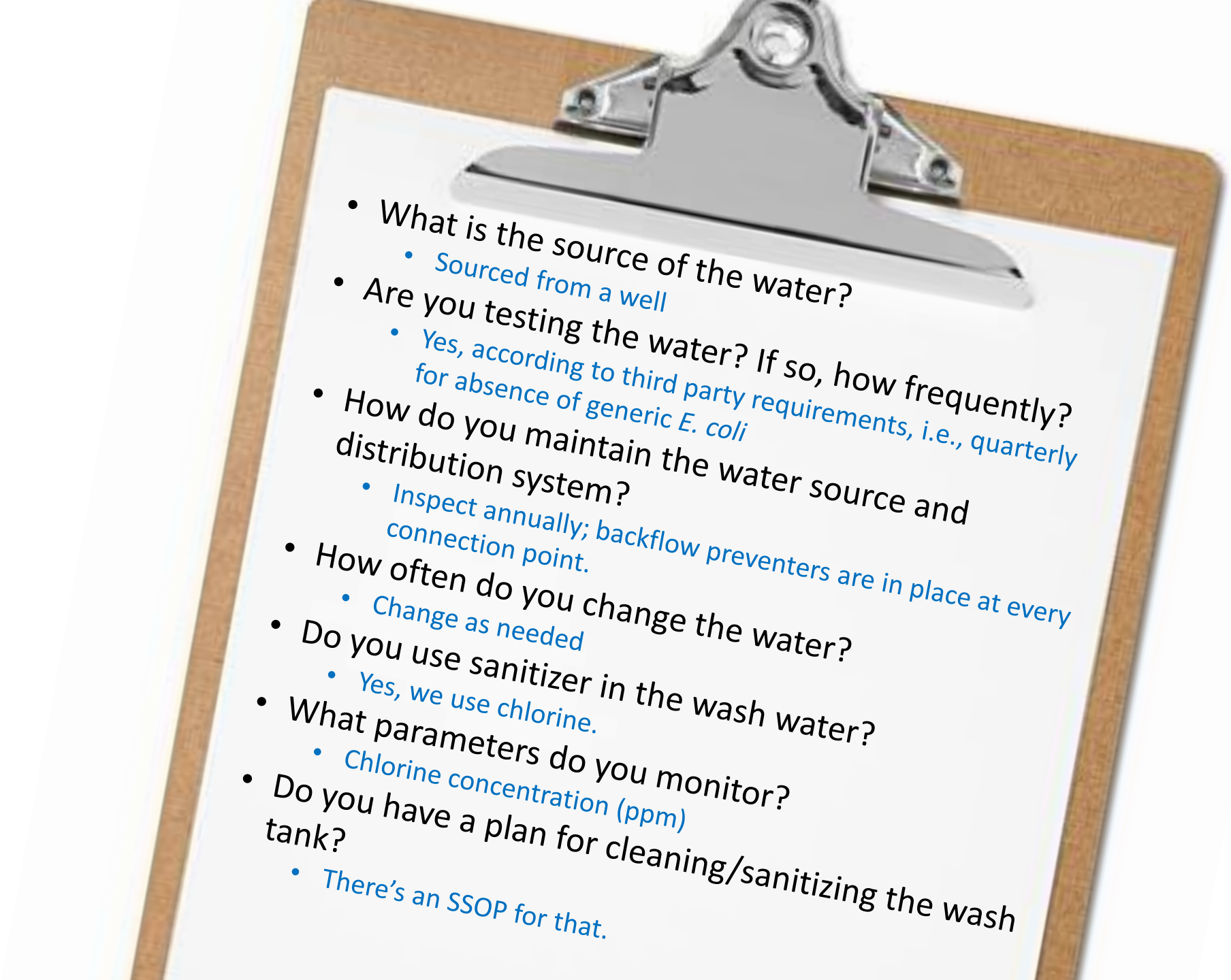
- The farm is fully covered by the PSR.
- The farm harvests multiple commodities; including tomatoes, eggplants, apples, carrots, pears, radishes, cantaloupes.
- All produce items are washed, and the farm utilizes a float tank for their wash process.

Focusing on postharvest agricultural water use, what are your initial top three questions to the farmer?
What rule requirements do they relate to?

Example Questions



Grower's Answers



- What is the source of the water?
  - Sourced from a well
- Are you testing the water? If so, how frequently?
  - Yes, according to third party requirements, i.e., quarterly for absence of generic *E. coli*
- How do you maintain the water source and distribution system?
  - Inspect annually; backflow preventers are in place at every connection point.
- How often do you change the water?
  - Change as needed
- Do you use sanitizer in the wash water?
  - Yes, we use chlorine.
- What parameters do you monitor?
  - Chlorine concentration (ppm)
- Do you have a plan for cleaning/sanitizing the wash tank?
  - There's an SSOP for that.

Digging a Little Deeper

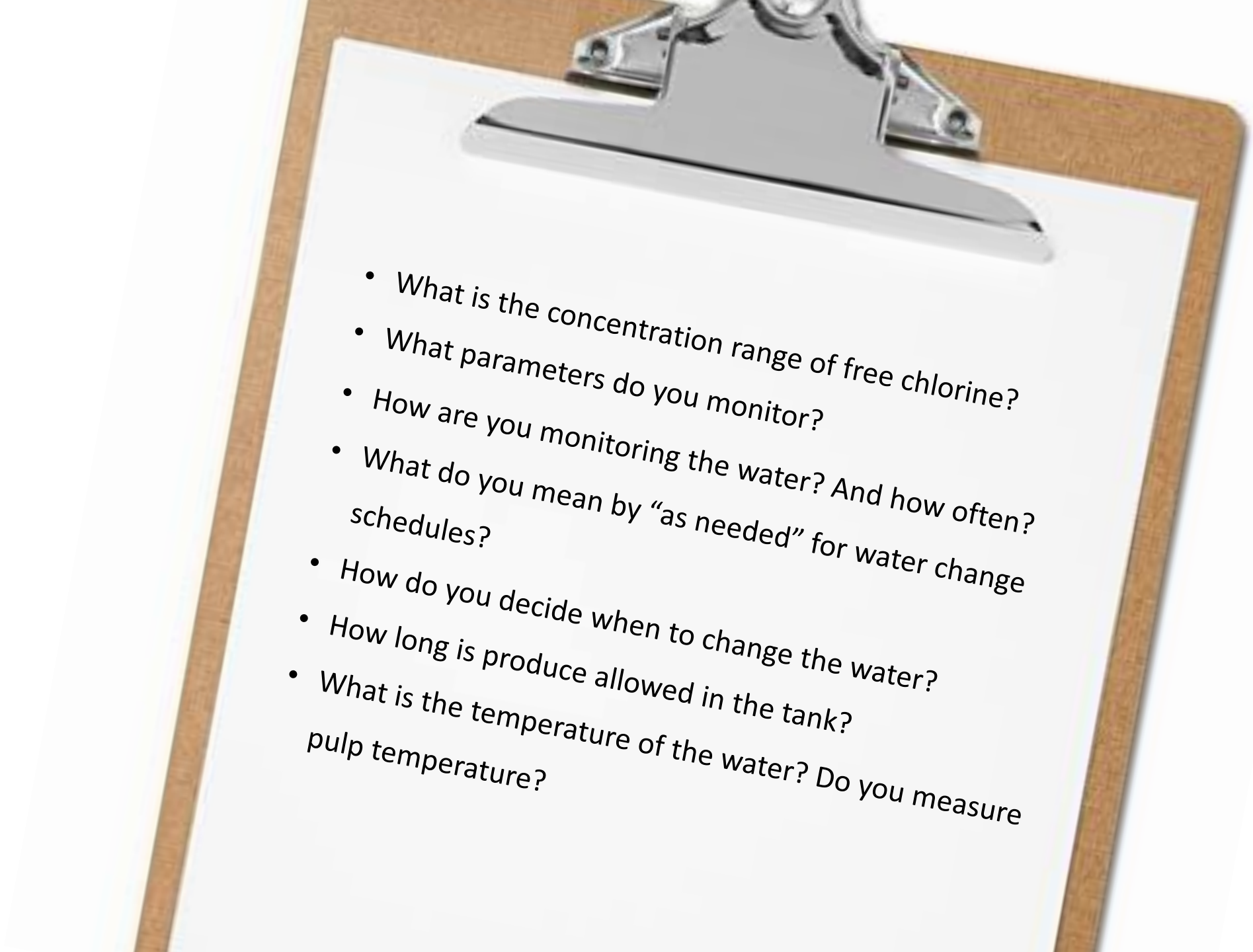
- Field bins are lowered into the tank to allow the apples to float out of the bin.
- This practice occurs throughout the day, and at times, several layers of fruit can be in the tank.
- According to the grower, fruit generally moves through the tank in a couple of minutes.
- Water is changed on an “as-needed” basis.
- The bins are cleaned at the same time as they wash the fruit.

Digging Deeper

- The farmer explains that they try to order their harvest so that commodities like tomatoes and eggplant are washed first in the morning.
- Apples and other pome fruits coming out of cold storage are washed later in the afternoon.
- Root crops, like carrots and radishes, are washed at the end of the day.
- The farmer says their strategy is to wash the ‘dirtiest’ produce last to maintain water quality.
- You observe staff going on a break and apples staying in water for longer than 15 minutes.

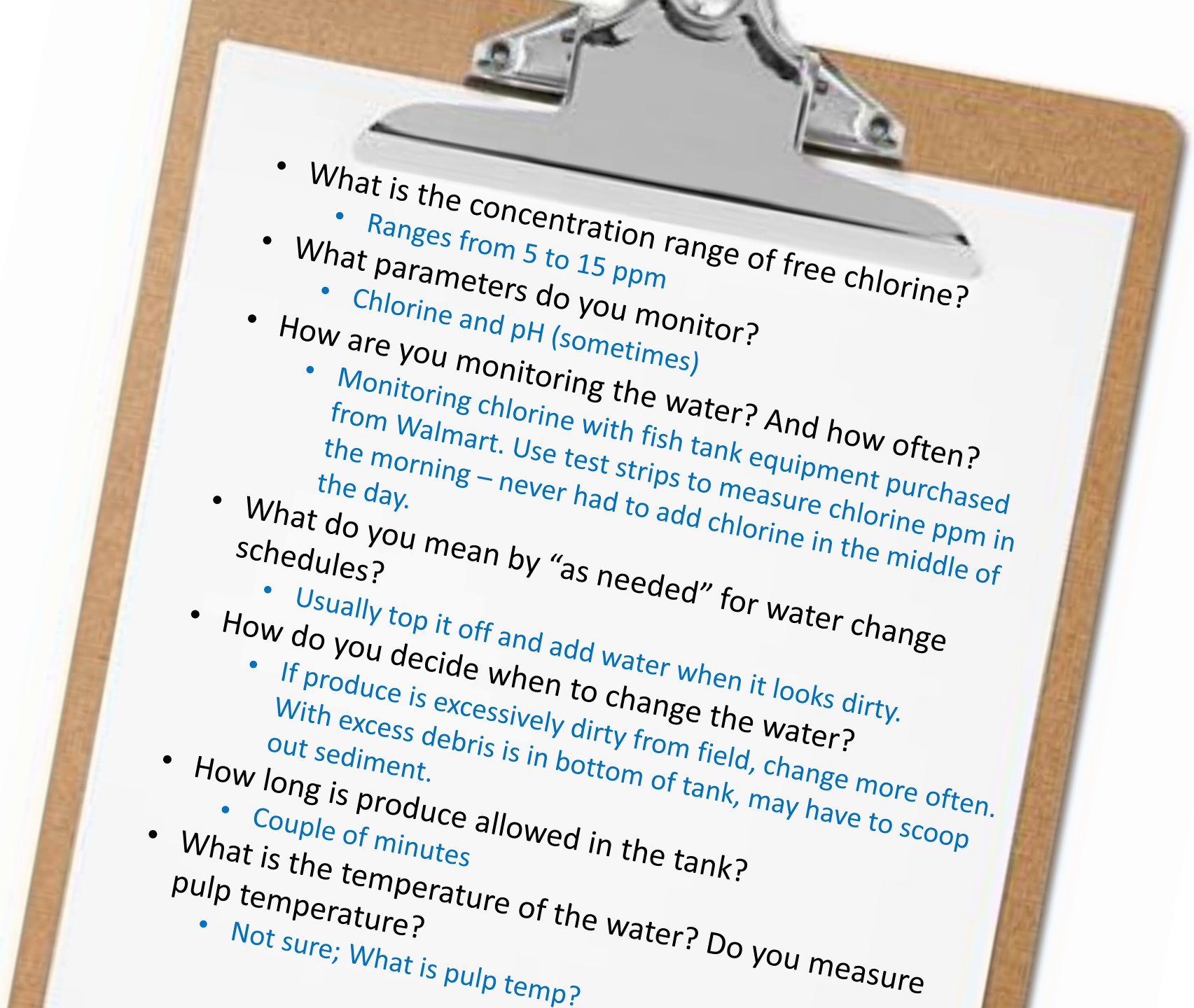
What are your top three questions to the farmer from this additional information?
What rule requirements do they relate to?

Sample of Questions



- What is the concentration range of free chlorine?
- What parameters do you monitor?
- How are you monitoring the water? And how often?
- What do you mean by “as needed” for water change schedules?
- How do you decide when to change the water?
- How long is produce allowed in the tank?
- What is the temperature of the water? Do you measure pulp temperature?

Sample of Questions



- What is the concentration range of free chlorine?
  - Ranges from 5 to 15 ppm
- What parameters do you monitor?
  - Chlorine and pH (sometimes)
- How are you monitoring the water? And how often?
  - Monitoring chlorine with fish tank equipment purchased from Walmart. Use test strips to measure chlorine ppm in the morning – never had to add chlorine in the middle of the day.
- What do you mean by "as needed" for water change schedules?
  - Usually top it off and add water when it looks dirty.
- How do you decide when to change the water?
  - If produce is excessively dirty from field, change more often. With excess debris is in bottom of tank, may have to scoop out sediment.
- How long is produce allowed in the tank?
  - Couple of minutes
- What is the temperature of the water? Do you measure pulp temperature?
  - Not sure; What is pulp temp?

For compliance with the PSR, what are your conclusions and top three recommendations or observations for the farmer?