EPA United States Environmental Protection Agency

Session 7: Simultaneous Compliance and Minimizing Disinfection Byproducts

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Simultaneous Compliance

- Without careful planning and proper implementation, actions intended to improve one aspect of regulatory compliance can produce conflicts (or at least pose challenges) in other areas of water quality performance.
- Simultaneous Compliance is the comprehensive assessment and implementation of processes and practices which promote compliance with all Safe Drinking Water Act (SDWA) regulations.
- Other compliance challenges with treatment changes – discharge permits and limits, sludge disposal etc.

State Primacy Agency Authority

- States must have authority to *"assure that the design and construction of new or substantially modified public water facilities will be capable of compliance with the State primary drinking water regulations."*

- Lead and Copper Rule requires *"as early as possible prior to the **addition of a new source or any long-term change** in water treatment, a water system deemed to have optimized corrosion control… shall **submit written documentation** to the State describing the change or addition.*

- *The State must **review and approve** the addition of a new source or long-term change in treatment **before it is implemented**… "*

What constitutes a “change” ?

- Long-term changes in unit process operation for regulatory compliance
- New technology implementation for regulatory compliance
- New sources of supply or modified use/blending of existing sources
- Any of the above even when primarily driven by **secondary** water quality standards

Acronyms

- DBP=Disinfection Byproducts
- DBP+=Potential for positive impacts to DBP levels/control
- DBP-=Potential for negative impacts to DBP levels/control
- DBP+/-=Potential impacts to DBP levels/control may be positive or negative depending on circumstance
- GWR=Groundwater Rule
- LCR=Lead and Copper Rule
- LT2ESWTR=Long Term 2 Enhanced Surface Water Treatment Rule
- Stage 2 DBP=Stage 2 Disinfection and Disinfection Byproducts Rule
- SWTR/IESWTR=Surface Water/Interim Enhanced Surface Water Treatment Rules
- RTCR=Revised Total Coliform Rule

SOURCE WATER SIMULTANEOUS COMPLIANCE ISSUES

Source/Capacity Changes

- New source, including interconnections, or new blending scenarios for existing sources
- New system ‘entry points’
- Increasing/Decreasing Pumping Capacity
- Shifts in Corrosion Control Treatment (CCT), Chemistry (pH, Oxidation/Reduction Potential (ORP), alkalinity, phosphate (PO4)) (DBP-)
- Climate/watershed changes – microbial, organic loading, turbidity, temperature (DBP+/-)

Source Water Change
Possible Conflicts/Challenges

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- LCR Corrosion Control Treatment (CCT) issues with shift in pH, Oxidation/Reduction Potential (ORP), alkalinity and/or Natural Organic Matter (NOM)
- Stage 2 DBPR issues with shift in Total Organic Carbon (TOC), NOM, chlorine demand, pH, alkalinity temperature (DBP+/-)
- SWTR, IESWTR issues due to changes in source water quality, Total Suspended Solids (TSS) and temperature
- Source quality/monitoring impacts LT2ESWTR “bin” placement for *Cryptosporidium* treatment requirements (DBP-)

Source Water Change
Possible Conflicts/Challenges

- Temperature shifts from Surface water/Ground water blending may help or hurt treatment – better mixing/coagulation but increased DPB formation?

- Alkalinity/hardness shifts require adjustment of coagulation/softening (DBP-)

- Interconnections/blending of sources treated differently – e.g. chlorinated with chloroaminated (DBP-)

GROUND WATER SIMULTANEOUS COMPLIANCE ISSUES

Reasons for Ground Water Simultaneous Compliance Concerns

- Source changes – long-term shifts in raw water quality, new sources, interconnections (DBP-? interconnection with surface water system)
- Treatment requirements – LCR, GWR 4-log virus treatment for significant deficiencies or indication of fecal contamination of the source (DBP-? source TOC)
- Maximum Contaminant Level (MCL) violations – TCR,IOCs,NO_3, volatile organic compounds (VOCs), synthetic organic compounds (SOCs)
- Ground water contamination/State MCLs or ALs – Perchlorate, MTBE, Hexavalent Chromium (Cr^{+6})

Ground Water Simultaneous Compliance Adding Disinfection

- GWR compliance
  - Enough contact time for 4-log virus inactivation?
  - Compliance monitoring requirement
  - Minimum residual requirements
- Subject to DBP MCLs and monitoring requirements, TOC and DBP precursors (e.g. Bromide) present?(DBP-)
- Distribution system residual monitoring and MRDLs
- Changes to corrosion control
- Operator certification

Ground Water Simultaneous Compliance Disinfection Changes

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- GWR compliance
  - Maintain virus inactivation?
  - Compliance monitoring changes
  - Minimum residual requirements (DBP-)
- Changes to DBP monitoring and compliance requirements (chlorine dioxide>>chlorite)(DBP-)
- Chloramination>>seasonal nitrification(DBP-)
- Changes to corrosion control

Ground Water Simultaneous Compliance VOC/SOC Removal

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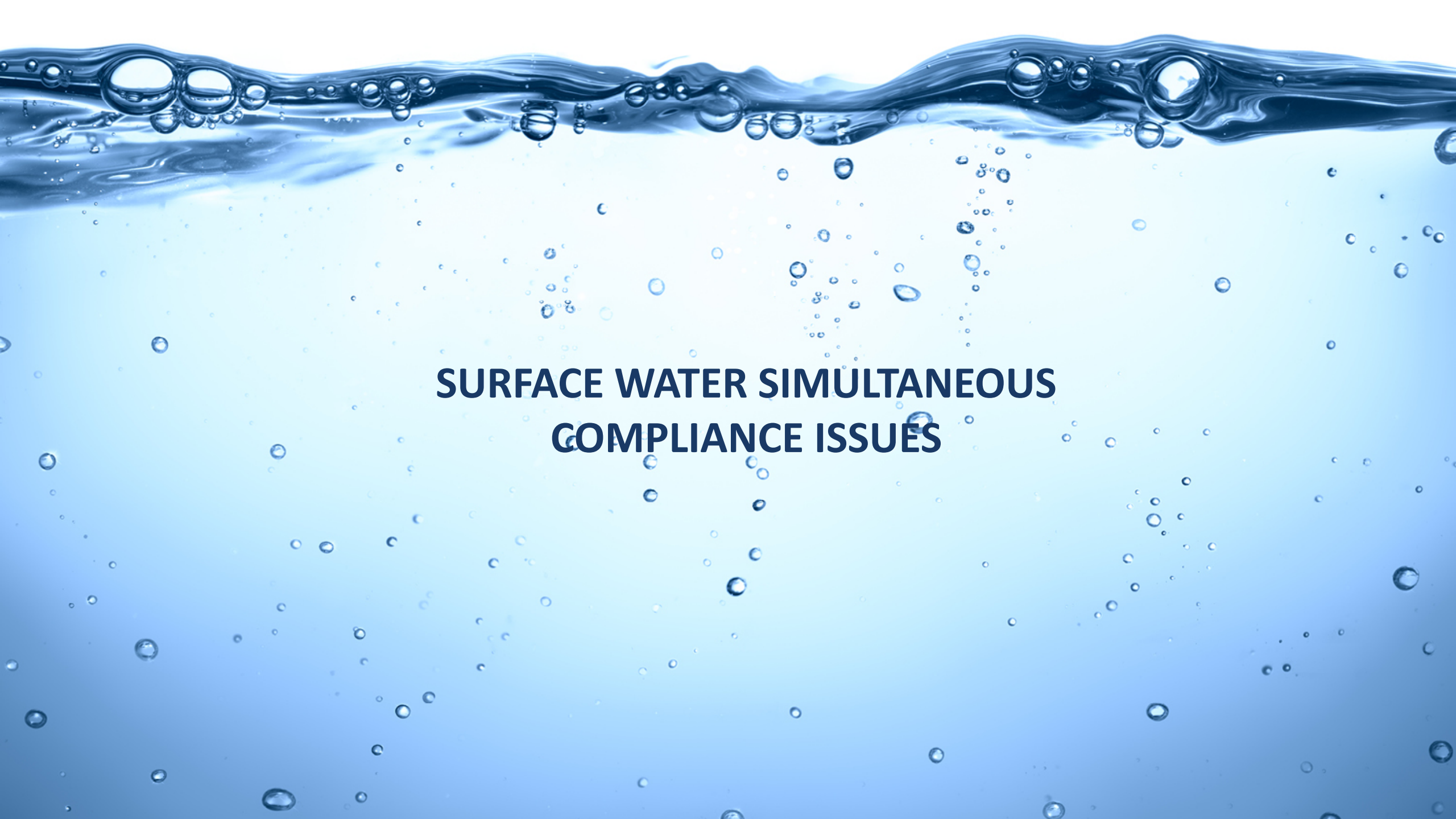
- **Aeration**
  - Increased scaling
  - State requirements to install disinfection
  - (DBP +? Reduce DBPs, source water TOC to form DBPs)
- **Granulated Activated Carbon (GAC)**
  - Limit prechlorination/move chlorination
  - Reduction in disinfectant residual
  - (DBP + reduction of precursor and DBPs already formed)
- **Nanofiltration/Reverse Osmosis**
  - Fouling by organics and minerals
  - Demineralization increases corrosivity
  - (DBP + reduction of precursor and DBPs already formed)

Ground Water Simultaneous Compliance Arsenic Treatment

- Pre-oxidation may be needed for adsorptive media, ion exchange or coagulation/filtration (DBP-,TOC,NOM present?)
- Coagulation/filtration less effective at pH>8 (DBP-, precursor removal)
- Ion Exchange-nitrate competes for absorptive sites (DBP+, DOM removal)
- Nanofiltration/Reverse Osmosis-pretreatment and post treatment needed (DBP+,DOM removal, DBP removal)
- Multiple simultaneous compliance issues (small systems)=DBPs, corrosion control, operator certification

Ground Water Simultaneous Compliance Nitrate Treatment

- Ion Exchange – arsenic, sulfate, etc. compete for absorptive sites (DBP+, DOM removal)
- Nanofiltration/Reverse Osmosis – pre and post treatment needed (DBP+, DOM removal)
- Multiple simultaneous compliance issues (small systems) – DBPs, corrosion control, operator certification



SURFACE WATER SIMULTANEOUS COMPLIANCE ISSUES

Surface Water Simultaneous Compliance Disinfection Changes

- Changes in inactivation (CT) achieved
- Oxidation of TOC, NOM may cause shifts in DBP formation/speciation (DBP-)
- Oxidation-related coagulation and filtration performance (DBP-, precursor removal)
- Interactions with adsorptive processes (e.g. Granular Activated Carbon, Ion Exchange) (DBP-, precursor removal)
- Conversion to chloramines may cause seasonal nitrification in distribution system (DBP-)
- Chlorine dioxide may form chlorides/chlorate under specific conditions (DBP-)

Surface Water Simultaneous Compliance Disinfection Changes

- Softening chemistry may limit disinfection alternatives upstream of granular media filtration
- Ozone impacts on downstream treatment processes (e.g., biological-regrowth; fouling of membranes) (DBP-, bromide to bromate)
- Shifts in pH, alkalinity, ORP and NOM may require re-optimization of CCT (DBP +/-)
- Changes in residuals production and characteristics

Disinfection Changes
Mitigating Potential Conflicts/Challenges

- Conduct site-specific treatability testing to establish how new oxidation conditions impact:
  - DBP speciation, bromate, chlorides/chlorates, total trihalomethanes (TTHM) formation potential analysis
  - Primary disinfection/CT
  - Coagulation/softening/corrosion
- Re-optimize CCT (if needed)
- Keep distribution system chemistry as consistent as possible to promote scale stability and avoid action level (AL) exceedances, minimize DBP formation or aesthetic problems

Surface Water Simultaneous Compliance Coagulation Changes

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- Flocculation/Sedimentation performance (DBP+/-, removal of TOC/NOM)
- Filter performance – shift in particle size distribution and character
- Increase in soluble aluminum may create post-precipitation problems
- Shifts in pH, TOC and alkalinity may impact LCR-CCT(DBP-, reduced precursor removal)
- Changes in residuals quantity or characteristics

Surface Water Simultaneous Compliance Softening Changes

Softening practices can have significant simultaneous compliance interactions

- May constrain primary disinfection options
    - Chlorine less effective at higher pH
    - Giardia CT not defined above pH 9
    - ClO_2 plus recarbonation >> Chlorates (DBP-)
    - High pH with ozone may form more bromate(DBP-)
- CCT Impacts
    - pH/Alkalinity/DIC shifts (DBP?)
    - Buffering capacity
    - Carbonate stability

Surface Water Simultaneous Compliance Other Changes

- **GAC (DBP+)**
  - Limits ability to pre-chlorinate
  - Reduction in disinfectant residual
  - Releases from biologically active GAC filters
  - Reduction of DBPs
- **Membrane/RO/NF (DBP+)**
  - Removal of precursors
  - Fouling by organics/precipitated minerals
  - Demineralization (RO and NF) increases corrosivity
  - Virus removal credit may be less>>disinfection changes?
  - High TDS reject stream-recycle, disposal?

DISTRIBUTION SYSTEM SIMULTANEOUS COMPLIANCE

TTHM/HAA5 Formation in the Distribution System

- Primary causes of excessive residence times that can contribute to TTHM/HAA5 formation in the distribution system:
  - **Low system demand**
    - Overall reduction in demand can increase residence time throughout distribution system
    - Reduced demand from high-volume water user can impact residence time in a specific area
  - **Dead ends and stagnant zones**
    - If two sources of water supply the distribution system, a stagnant zone could be occurring
  - **Water Age**

Increased TTHM/HAA5 Formation Resulting from Storage Tank Operations

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- **Discharge of stagnant water**
  - Review tank configuration and operations to identify stagnant zones
  - Review tank level records to determine if tank was drawn down to unusually low levels, allowing water from stagnant zones to enter distribution system
- **Increased residence time**
  - Can result if water in the storage facility is turned over infrequently or tanks “float”
  - Check tank operating levels and system demands to determine if excessive residence time occurred prior to OEL exceedance or MCL violation
  - Check temperature and disinfectant residual data for water discharged from tank - loss of residual and/or increased temperature may indicate high residence time
- **Sediment in tank**
  - Check maintenance records to determine last time tank was drained and cleaned

System Characteristics that Affect Water Age

- Water main size
- Distribution system configuration
  - Loops
  - Dead-ends
  - Pressure zones
  - Closed valves
- System demand including seasonal changes
  - Unoccupied buildings
  - Water conservation measures

DBP Control Options for Consecutive Systems

- *Manage Water Age, Manage Water Age, Manage Water Age*
- Flush routinely as a preventative (proactive) measure
- Check the positions of all valves
- Determine how does water move (or not) through the system
  - Hydraulic modeling (see EPANET)
- Add loops/connect zones

DBP Control Options for Consecutive Systems

- Is booster chlorination really needed?
- Can booster chlorination for areas or systems with residual problems help? Reduce doses from the plant to reduce formation
- Can storage tanks that float on the line be changed to flow through?
- Can storage be operated differently?
  - Increase fill time and inlet momentum-pump changes, reduce inlet diameter
  - Mechanical mixing
  - Excess/overbuilt storage taken out of service

Distribution System Simultaneous Compliance

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- Maintaining a stable pH and stable residual has multiple simultaneous compliance benefits
- Stage 2 DBP
- RTCR
- LCR Rule

Best Practices

- ***Alabama*** and ***Tennessee*** require sample collection at consecutive system interconnections and the wholesaler must conduct OEL if triggered by the consecutive system
- Use of optimization practices or special training programs to identify causes and develop approaches to improve system performance
- ***Kentucky SDWS program*** works with enforcement program to identify cause of DPB violation and develop a return to compliance path including optimization
- Challenges with data/different labs with variable results may be improved with use of newer methods (552.3, 524.3 and 524.4) using newer instrumentation. Additional QC specifications for analyses
- ***North Dakota*** provides peer training sessions with systems with common challenges sharing their return to compliance approaches

Consecutive Systems and DBP Compliance

- Consecutive systems do have options to control DBP levels
  - Water age management
  - Good utility practice (locating valves, etc.)
  - Monitor water quality and set internal goals
  - Take corrective action based on water quality triggers
  - Consider water age reduction and residual maintenance as part of distribution system rehabilitation and capital improvement plans

Ideally, water age and water quality management are part of operating the combined distribution system of the wholesale and consecutive systems

Operational Evaluation Level

- Early warning for systems with possible MCL violations
- Consideration of possible health effects from spikes or very elevated periods
- Consider as part of oversight of operations, plan or project review
- Do repeated OEL exceedances have the same cause? Did something change that quarter?

Stage 2 DBP TTHM & HAA5 MCL Compliance Calculations

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- **Quarterly Sampling**
  - Locational Running Annual Average (LRAA) – must be calculated at the end of each quarter
  - For failure to collect four consecutive quarters LRAA is based on the average of available data from the most recent four quarters (CFR 141.620(d))
  - Any LRAA of quarterly averages that is > MCL is a violation

- **Annual Sampling**
  - Annual sample > MCL is not a violation unless the result would cause LRAA to be > MCL (Annual sample ≥4XMCL)
  - Return to quarterly sampling with Annual sample as Q1 for LRAA calculation

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