



SOUTHWEST
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US Territories Water Operator Training Series

Session 17: Lead & Copper Rule and Corrosion Control

03/05/2026

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and Specialist**

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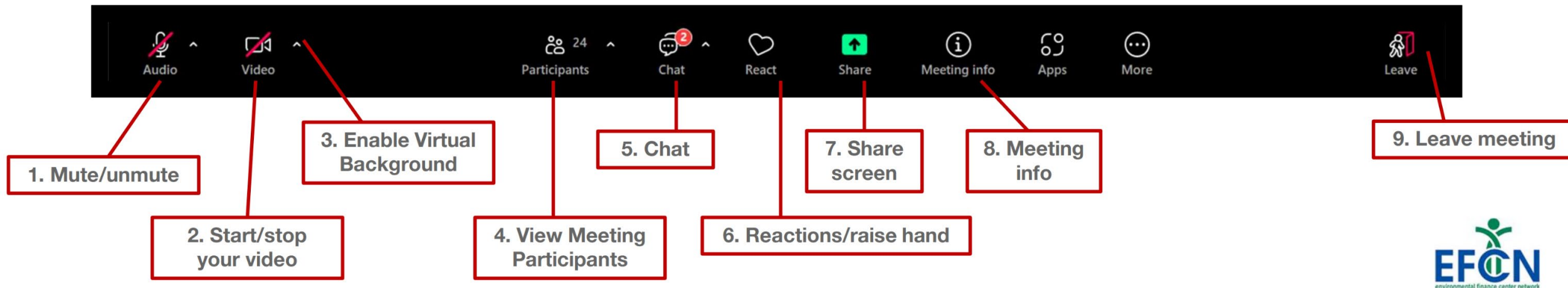
SCHOOL OF
ENGINEERING



This training series is funded by the US EPA

Attendee Meeting Controls

- Locate your control bar
- All attendees will see a black horizontal bar on their screen
- If your control bar is not visible, it may be hidden
 - Move your cursor to the screen's bottom (or top) to reveal this control bar.



Schedule for 2026:

Date	Topic
1/22/2026	Alternative Treatment Processes (e.g. fluoridation, ion exchange, RO...)
2/5/2026	Drinking Water Treatment Math & Concept Review
2/19/2026	Safety Program Basics (including personal safety, equipment safety, facility safety)
3/5/2026	Lead & Copper Rule, Corrosion Control
3/19/2026	Distribution Systems 1: Hydraulics, Pipe Types, Selection, Installation, and Water Quality
4/2/2026	Distribution Systems 2: Valves, Hydrants, Meters, and Service Connections
4/16/2026	Distribution Systems 3: Storage and Booster Pumping
4/30/2026	O&M: Pumps, Main, and Appurtenance Maintenance (including pressure monitoring, valve exercising, and flushing)
5/14/2026	O&M: Cross Connection Control
5/28/2026	O&M: Distribution System Math and Concept Review
6/11/2026	Sampling & Lab Procedures/Analysis/Interpretation
6/25/2026	Management Overview (including organization, communication, PR & record keeping)
7/9/2026	Drinking Water Practice Exam and Review

Links to recordings and material are available on our website at <https://swefc.unm.edu/home/op-cert-trainings/>

Pacific Island Territories Operator Certification Trainings

This page is a repository of Wastewater and Drinking Water Operator Certification (Op Cert) Training Webinars offered by the SW EFC for systems in the Pacific Territories. Below you will find the **training webinar schedules (wastewater, then drinking water)** followed by a **training webinar recordings library**.

[Jump to Wastewater Trainings](#) [↓](#)[Jump to Drinking Water Trainings](#) [↓](#)

Wastewater Training Schedule

Please note all times are local to CNMI and Guam. The times in American Samoa are one day earlier at 11 am.

Session	Date	Training Topic & Link to Recording (click to view)	Supporting Materials (click to download)
1	6/25/2025	Program Overview, Test Format, Study & Test Tips	PPT slides
2	7/9/2025	Treatment Overview	PPT slides
3	7/23/2025	WW Math Part 1 (Areas & Volumes)	PPT slides
4	8/6/2025	WW Math Part 2 (Flow Rates & Detention Times)	PPT slides
5	8/20/2025	Collection Systems – Gravity systems	PPT Slides

Sign in for every session to ensure you get credit for attending



**US Territories Water & Wastewater Operator Certification
Virtual Training Series Group Attendance Sheet**

Session Title: _____

Session Date: _____

Training Location: _____

Attendee Name	Attendee Signature	Arrival Time	Departure Time

I hereby certify that the individuals listed above attended the referenced training session.

Name: _____
Signature: _____
Title: _____
Date: _____

Please scan this sheet after each training session and email it to swefc@unm.edu with the subject line: "US Territories Op Cert Attendance Sheet"

Lead and Copper Rule

What are the Lead & Copper Rules?



The OG Lead & Copper Rule (LCR)



The Lead & Copper Rule Revisions (LCRR)



The Lead & Copper Rule Improvements (LCRI)

Sources of Lead & Copper in Drinking Water



Lead and Copper Pipes



The corrosion of household plumbing and fixtures



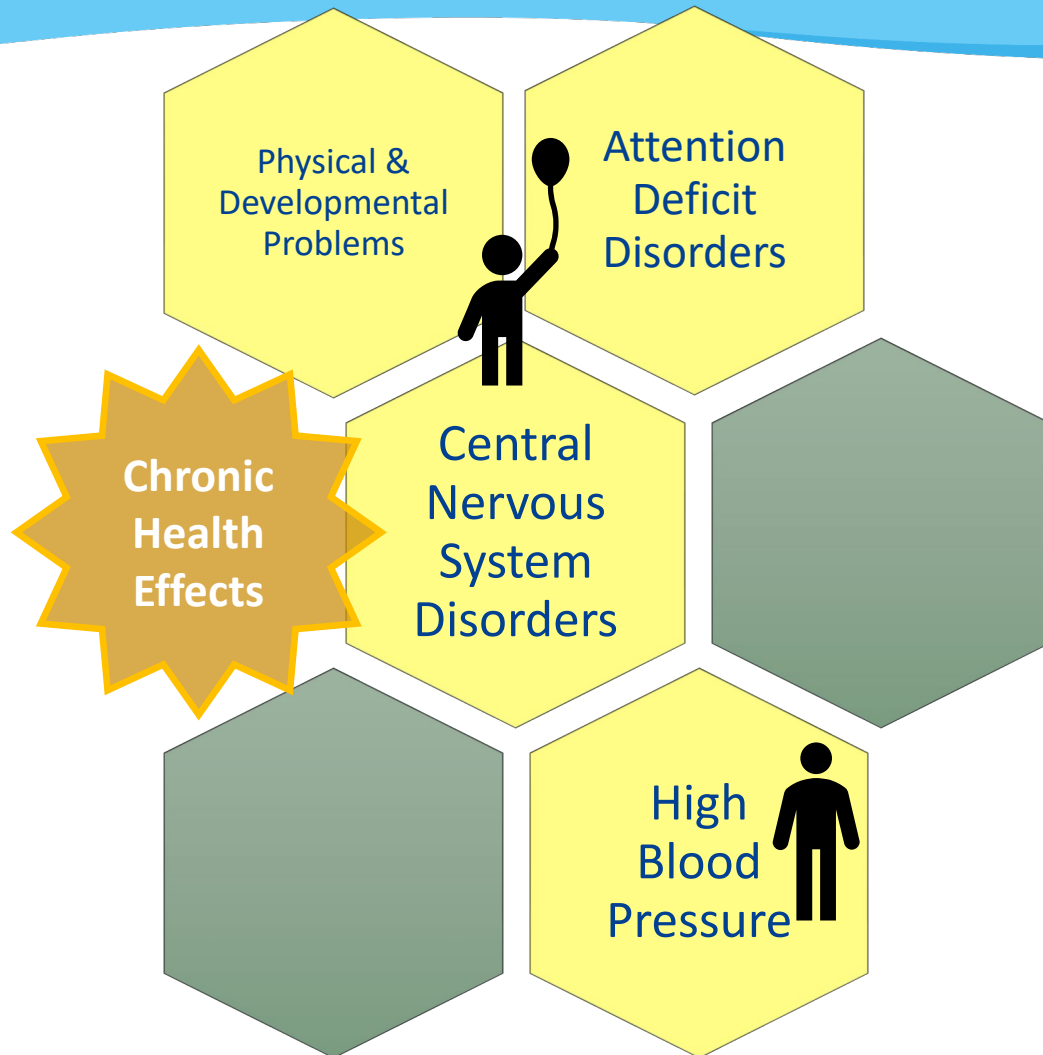
Lead Solder at Pipe Joints



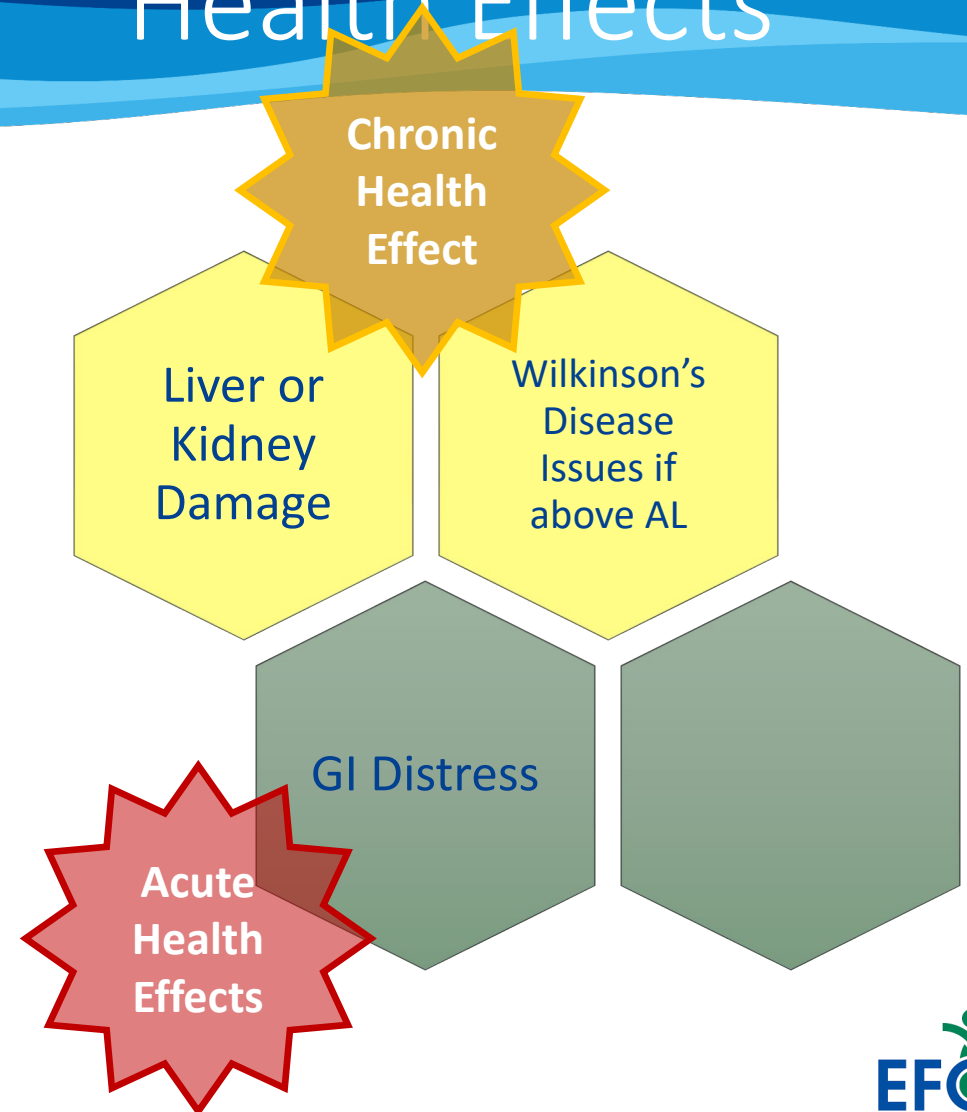
Brass Fittings

Galvanized Pipes
(in downstream locations of LSLs)

Lead (Pb) Health Effects



Copper (Cu) Health Effects



The Lead & Copper Rule



**Which Systems
Have to Sample?**

Monitoring Requirements

- Frequency of sampling:
 - Monitoring schedules:
 - Standard
 - Reduced

Standard (Baseline)



- New Systems
- New Water Sources
- Change in Treatment
- Two consecutive 6-month periods

Reduced



- Systems with no lead or copper concerns
- Reduced frequency:
 - yearly
 - every 3 years
- Reduced number of samples (half)

Types of LCR Compliance Monitoring Schedules

Standard (Increased)



- Exceed lead or copper action level
- Increased to every 6 months

Monitoring Requirements

- Frequency of sampling:
 - Monitoring schedules:
 - Standard
 - Reduced
- Number of samples based on:
 - Population size
 - Monitor schedule

How Many Lead & Copper Samples Do I Need to Take?

Minimum Number of Required Lead and Copper Samples

System Size (number of people served)	Standard number of sites	Reduced number of sites
≤100	5	5
101 - 500	10	5
501 – 3,300	20	10
3,301 – 10,000	40	20
10,001 – 100,000	60	30
>100,000	100	50

How Many LCR Samples Does this Community System Have to Take on Standard Monitoring?

Total Population:	10,026
-------------------	--------

Minimum Number of Required Lead and Copper Samples

System Size (number of people served)	Standard number of sites	Reduced number of sites
≤100	5	5
101 - 500	10	5
501 – 3,300	20	10
3,301 – 10,000	40	20
10,001 – 100,000	60	30
>100,000	100	50

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>100,000	100	50

60

How Many LCR Samples Does this Community System Have to Take on Reduced Monitoring?

Total Population:	10,026
-------------------	--------

Minimum Number of Required Lead and Copper Samples

System Size (number of people served)	Standard number of sites	Reduced number of sites
≤100	5	5
101 - 500	10	5
501 – 3,300	20	10
3,301 – 10,000	40	20
10,001 – 100,000	60	30
>100,000	100	50

How Many LCR Samples Does this Community System Have to Take on Reduced Monitoring?

Total Population:	10,026
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Minimum Number of Required Lead and Copper Samples

System Size (number of people served)	Standard number of sites	Reduced number of sites
≤100	5	5
101 - 500	10	5
501 – 3,300	20	10
3,301 – 10,000	40	20
10,001 – 100,000	60	30
>100,000	100	50

30

Monitoring Requirements

- Frequency of sampling:
 - Monitoring schedules:
 - Standard
 - Reduced
- Number of samples based on:
 - Population type and size
 - Monitor schedule
- Seasonality
 - Monitor schedule

Group Non-TCR Sample Schedules					
Facility	Begin End Date	Seas.	Init. MP Begin Dt	Req's	Analyte Group
10701000	01-01-2011 Continuous	6/1 9/30	01-01-2011	50 RT/3Y	PBCU - LEAD AND COPPER

Schedule Information

Analyte/Group PBCU - LEAD AND COPPER	Sampling Frequency 50 RT VERY 3 YEARS	Facility 09623000 - DIST	Collection Period 6/1 - 9/30	Initial Monitoring Period Begin Date 01/01/2023	Schedule Begin Date 01/01/2023
Notes					

Requirements	Last Result Received	Next Sampling Due Date	Following Sampling Due Date	Current Status Monitoring Frequency	Comments:
Contaminant Names					
DS000 DISTRIBUTION SYSTEM					
Lead & Copper	5 samples required	between June 1 and Sept 30.	5 samples outside this period will be invalid.		
		09/30/2025	9/30/2026	Reduction Every year	

CHEMICAL Sampling Schedules						
FACILITY ID: 01000			FACILITY NAME: DISTRIBUTION SYSTEM			
SAMPLE TYPE:	SAMPLE LOCATION:	SCHEDULE BEGIN DATE	FREQ:	YEAR to SAMPLE:	WHEN TO SAMPLE:	NUMBER TO TAKE:
Lead & Copper	At sample sites in your lead and copper sample plan.	7/1/2023	6M	2024	January-June and July-December.	20

Monitoring Requirements

- Frequency of sampling:
 - Monitoring schedules:
 - Standard
 - Reduced
- Number of samples based on:
 - Population type and size
 - Monitor schedule
- Seasonality
 - Monitor schedule
- Sample site locations

LCR Site Criteria

Revised Tiering Criteria under the Final LCRI

Sample Site Tier	Description
Tier 1	Single-family structures (SFS) with premise plumbing made of lead and/or served by an LSL.
Tier 2	Buildings, including multiple-family residences, with premise plumbing made of lead and/or served by an LSL.
Tier 3	SFS served by a lead connector. SFS served by a galvanized service line or containing galvanized premise plumbing identified as ever having been downstream of an LSL.
Tier 4	SFS that contain copper premise plumbing with lead solder installed before the effective date of the State's applicable lead ban.
Tier 5	SFS or a building in which the plumbing materials used at that site would be commonly found at other sites served by the water system (i.e., representative of sites throughout the distribution system).

LCR Sampling Plan



LCR 007	Jay Walker	TR 005, Hse # 24		
LCR 013	Justin Thyme	TR 006, Hse # 60	Kitchen sink (KS)	T1

Where do we collect Lead & Copper samples?



- Consumers Taps:
- kitchen sinks
 - breakroom sinks
 - bathroom sinks



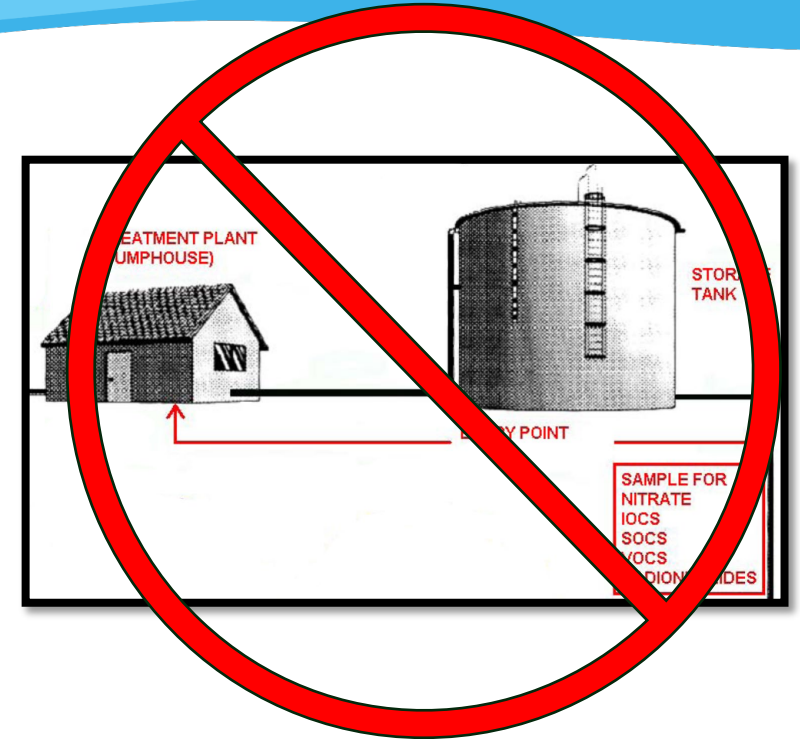
Where NOT to collect LCR samples



When sample locations
are inactive



Abandoned Homes



Entry Points

LCR Sampling

- Use interior customer cold-water taps
- First draw where the water has stood in the pipes for at least 6 hours
- For NTNC systems ensure sample tap shutdown
- Do not flush taps
- Do not remove aerator

TESTING WHERE THE LEAD IS

For homes with lead service lines, the 1st and 5th liter of water must be tested for lead.



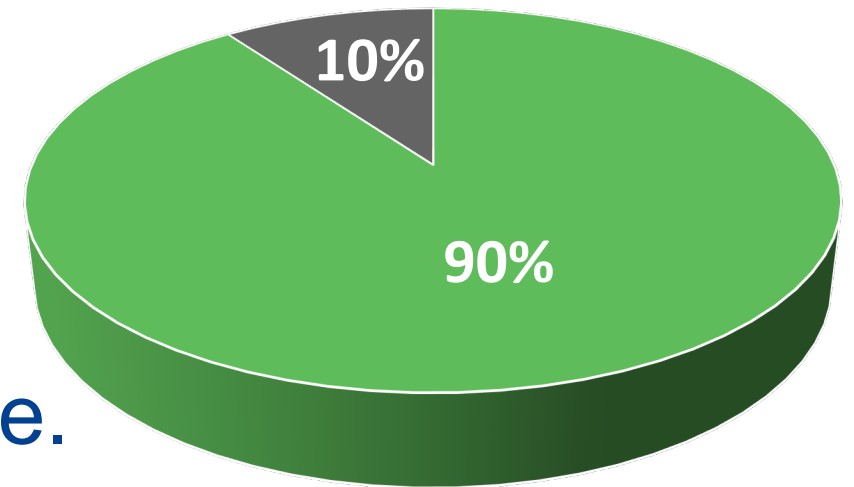
Understanding Lead & Copper Sample Results

Action Levels (AL) - based on 90th percentiles

- Lead - **0.010 mg/L** (10 ppb)
- Copper - **1.3 mg/L** (1.3 ppm)

GOAL = **Zero** for Lead

*If 90% of sample results are at or below the AL value, no exceedance.



Understanding Lead & Copper Sample Results

Original Lead Results	
Site A	0.001 mg/L
Site B	0.003 mg/L
Site C	0.002 mg/L
Site D	non-detect
Site E	0.006 mg/L
Site F	0.001 mg/L
Site G	0.001 mg/L
Site H	0.002 mg/L
Site I	0.022 mg/L
Site J	0.001 mg/L

Lead = **0.010 mg/L**

Understanding Lead & Copper Sample Results

1. Order the results from highest to lowest

Original Lead Results

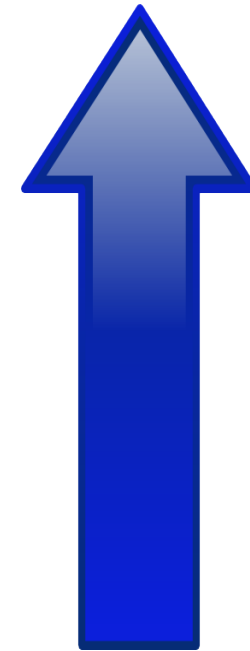
0.001 mg/L
0.003 mg/L
0.002 mg/L
non-detect
0.006 mg/L
0.001 mg/L
0.001 mg/L
0.002 mg/L
0.022 mg/L
0.001 mg/L



Reordered Results

0.022 mg/L
0.006 mg/L
0.003 mg/L
0.002 mg/L
0.002 mg/L
0.001 mg/L
0.001 mg/L
0.001 mg/L
0.001 mg/L
non-detect

Highest Value



Lowest Value

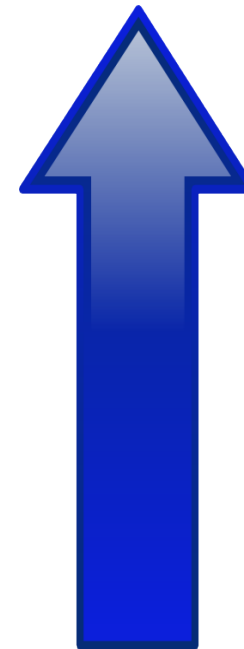
Understanding Lead & Copper Sample Results

2. Number the results with 1 being the lowest value, 2 being the next higher value on up

Reordered Results

10	0.022 mg/L
9	0.006 mg/L
8	0.003 mg/L
7	0.002 mg/L
6	0.002 mg/L
5	0.001 mg/L
4	0.001 mg/L
3	0.001 mg/L
2	0.001 mg/L
1	non-detect

Highest Value



Lowest Value

Understanding Lead & Copper Sample Results

3. Find the 90th percentile value

Lead = 0.010 mg/L >

(# of samples) x 0.9

Example: 10 x 0.9 = 9

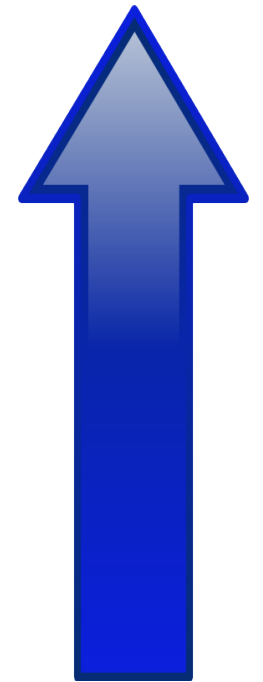
9th sample

If 10 samples = 9th highest sample
If 20 samples = 18th highest sample
If 5 samples = avg 4th & 5th samples

Reordered Lead Results

10	0.022 mg/L
9	0.006 mg/L
8	0.003 mg/L
7	0.002 mg/L
6	0.002 mg/L
5	0.001 mg/L
4	0.001 mg/L
3	0.001 mg/L
2	0.001 mg/L
1	0.001 mg/L

Highest Value



Lowest Value

Collecting Lead & Copper at the Source After an ALE

- Source water monitoring for Lead & Copper
- Water quality parameter (WQP) monitoring at EP & DS (compliance monitoring):
 - pH and Temperature (field)
 - Total Alkalinity (lab)
 - Calcium (lab)
 - Conductivity (lab)

ALE

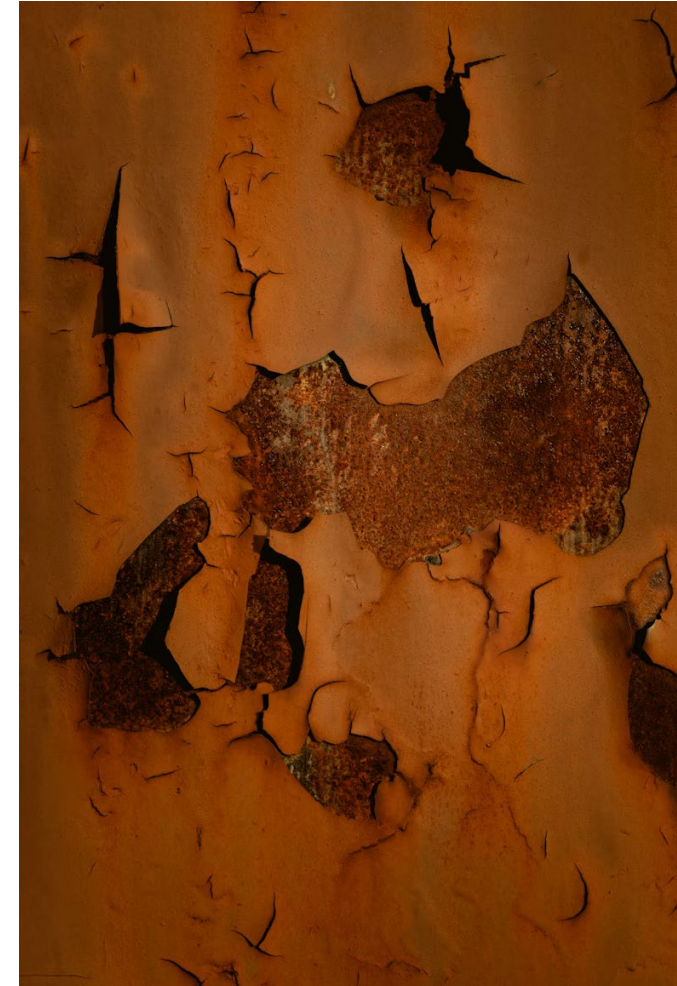
What if an Action Level is Exceeded?

- Public notification within 24 hours (Tier 1 PN)
- Public education
- Lead service line replacement
- Under-sink fixture replacement
- Determine optimal corrosion control treatment

ALE

Corrosion Control

Corrosion - Corrosion is a natural process that converts a refined metal into a more chemically stable oxide. It is the gradual deterioration of materials by chemical or electrochemical reaction with their environment. (Wikipedia)



Why is corrosion a concern for water systems?



- Water quality issues (e.g., lead or copper in drinking water)
 - Creates health concerns
 - Taste and odor issues
- Material degradation
 - Additional replacement and maintenance costs
- Water loss
 - Through leaks caused by degradation

Scale in drinking water

Scale forming water

- Deposition of dissolved minerals onto pipe / appurtenances
- Decreased lifespan and flow



Corrosion is an oxidation-reduction reaction (redox)

Oxidation examples: Lead metal losing electrons at anode

- $\text{Pb} \leftrightarrow \text{Pb}^{2+} + 2\text{e}^-$
- $\text{Pb} \leftrightarrow \text{Pb}^{4+} + 4\text{e}^-$

Reduction examples: Oxidant gaining electrons at cathode

- $\text{OCl}^- + \text{H}^+ + 2\text{e}^- \leftrightarrow \text{Cl}^- + \text{OH}^-$
- $2\text{OCl}^- + 2\text{H}^+ + 4\text{e}^- \leftrightarrow 2\text{Cl}^- + 2\text{OH}^-$

Oxidant is dissolved oxygen, free chlorine, chloramine, chlorine dioxide, etc.

Galvanic Corrosion

- Galvanic corrosion – caused by use of dissimilar metals

TABLE 9-2 Galvanic series for metals used in water systems

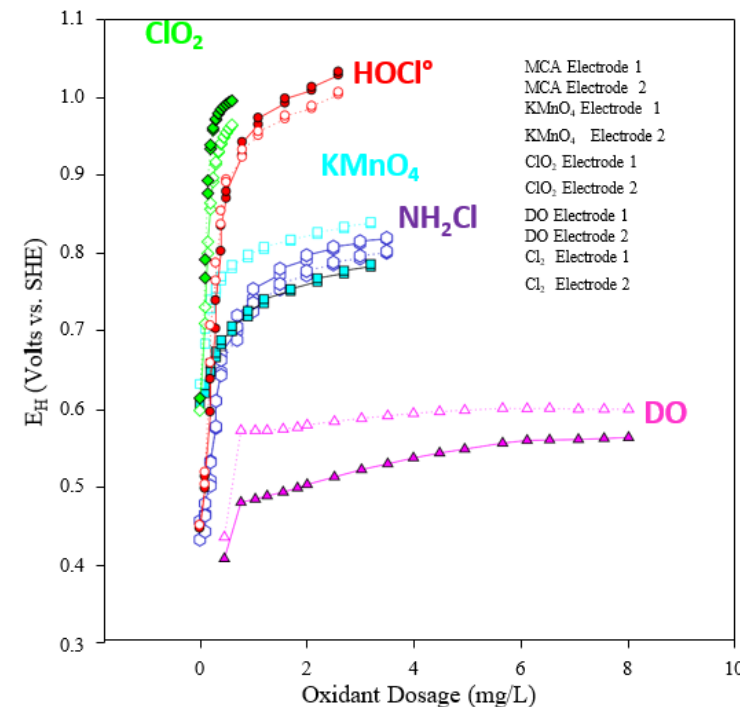
Corroded End (Anode)	MOST ACTIVE
Magnesium	+
Magnesium alloys	
Zinc	
Aluminum	
Cadmium	
Mild steel	
Wrought (black) iron	
Cast iron	Corrosion Potential
Lead–tin solders	
Lead	
Tin	
Brass	
Copper	
Stainless steel	—
Protected End (Cathode)	LEAST ACTIVE



DeSantis et al., 2018

Factors affecting corrosion and scale

- Presence of oxidants (e.g., oxygen, chlorine)
- Total dissolved solids
- Chloride and sulfate
- Alkalinity and pH
- Corrosion inhibitors
- Temperature
- Flow velocity
- Type of metal
- Electrical current
- Bacteria



Oxidation-Reduction Potential of several disinfectants in experiment

James et al., 2004
(pH 7, 10 mg C/L, 25°C)

Corrosion applicability

- Service lines
- Plumbing
- Fixtures



Corrosion applicability

- Storage tanks



Corrosion applicability

- Distribution lines and components



Corrosion applicability

- Anything metal



Models to predict corrosivity

Based on water quality parameters, predict if water is more likely to cause corrosion or deposit scale

- Langelier Saturation Index
- Ryznar stability index
- Free online tools or more advanced models for purchase

AutoSave On example - Saved

File Home Insert Draw Page Layout Formulas Data Review View Automate Help Acrobat

Paste Cut Copy Format Painter Clipboard Font Alignment Number

C34 =2*\$PHS-_PH2

The RTW Model Ver. 3.0 ID:		
STEP 1: Enter initial water characteristics.		
Measured TDS	804	mg/L
Measured temperature	20.22	deg C
Measured pH	7	
Measured alk, as CaCO3	370	mg/L
Measured Ca, as CaCO3	98	mg/L
Measured Cl	65	mg/L
Measured SO4	150	mg/L
For CT and TTHM functions enter current:		
Treated water pH	6.2	mg/L
Chlorine residual	0	mg/L
Chlorine or hypochlorite dose as chlorine equivalent	0	mg/L
STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Alt+C to select chemicals for this list.		
Alum 50% solution	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Soda ash	0	mg/L
Sodium bicarbonate	0	mg/L
Ctrl+C to add to list	0	mg/L
STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.		
Theoretical interim water characteristics		Desired
Interim alkalinity	370 mg/L	> 40 mg/L
Interim Ca, as CaCO3	98 mg/L	> 40 mg/L
Alk/(Cl+SO4)	1.7	> 5.0
Theoretical interim water characteristics		Desired
Interim pH	7.00	6.8-9.3
Precipitation potential	-37.87 mg/L	4-10 mg/L
Langelier index	-0.35	>0
Press PAGE DOWN for additional initial, interim and final water characteristics if desired.		
Calculated initial water characteristics		
Initial acidity	526	mg/L
Initial Ca sat, as CaCO3	217	mg/L
Initial DIC, as CaCO3	896	mg/L
Theoretical interim water characteristics		
Interim acidity	526	mg/L
Interim Ca sat, as CaCO3	217	mg/L
Ryznar index	7.69	
Interim DIC, as CaCO3	896	mg/L
Aggressiveness Index	11.56	
Theoretical final water characteristics after CaCO3 precipitation		
Final alkalinity	N/A	mg/L
Final Ca	N/A	mg/L
Final acidity	N/A	mg/L
Final pH	N/A	
Final DIC, as CaCO3	N/A	mg/L
Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.		
CT and TTHM Results		
Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

Control of corrosion and scale

- Removing metallic materials from system
 - Lead and copper pipe, old fittings and fixtures
- Alteration of water chemistry
 - pH/alkalinity

pH/Alkalinity Adjustment

- Sodium Hydroxide (caustic soda) – increase pH
- Carbon Dioxide – decrease pH
- Muriatic Acid (HCl) – decrease pH
- Calcium Carbonate – increase alkalinity
- Sodium Carbonate (Soda ash) – increase alkalinity



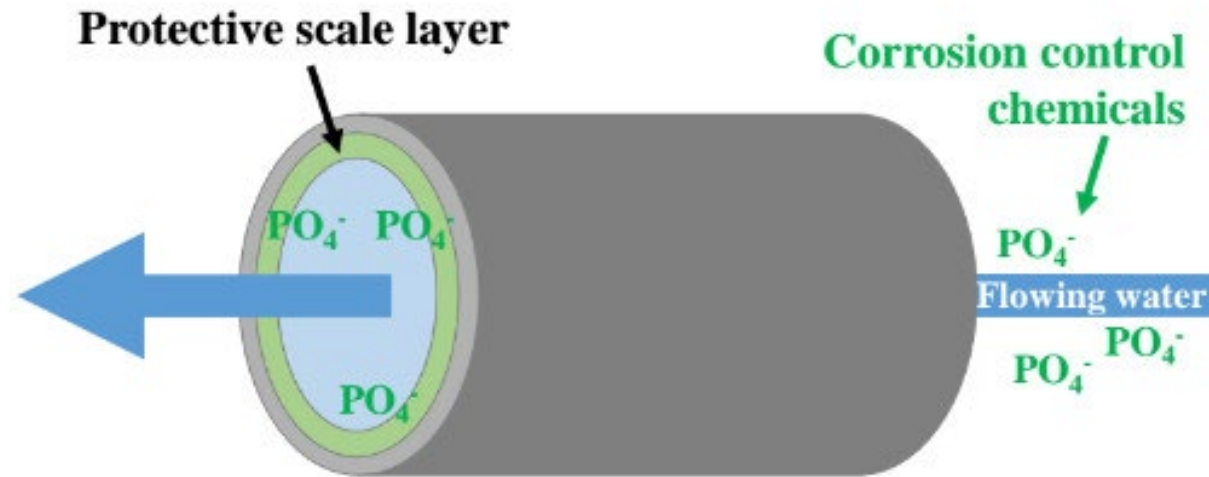
Control of corrosion and scale

- Removing metallic materials from system
 - Lead and copper pipe, old fittings and fixtures
- Alteration of water chemistry
 - pH/alkalinity
 - Addition of corrosion inhibitor

Corrosion inhibitor

Reduce corrosivity of water by forming a protective film on pipes due to corrosive water

- Addition of orthophosphate or polyphosphate



Corrosion Control Treatment under the LCR

- Action Level Exceedance
- Corrosion control study
- Determination of corrosion control treatment
- Follow up monitoring
- Optimized or re-optimized corrosion control treatment



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