Lead and Copper Rule
and Treatment Overview

for the
Wisconsin Wastewater Operator’s Association
2018 Annual Conference

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Public Water Engineering Section

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Lead and Copper Overview

- Sources of lead and contribution to DW
- LCR monitoring
- Assessing efficacy of treatment
- Treatment options
- Conclusions
Sources of Lead and Contribution to DW

Main: 3% - 15%

Lead Service: 50% - 75%
Sources of Lead and Contribution to DW

PUBLIC
PRIVATE

Lead Service: 50% - 75%

Faucet: 1% - 3%
Premise: 20% - 35%

Main: 3% - 15%

Communication pipe
Water main
Gooseneck or pigtail
Alternate position of water meter

Water meter
Internal plumbing
Isolation valve

Faucet stop
Sidewalk
Property boundary
Landscaping

Street
Communication pipe
Gooseneck or pigtail
Alternate position of water meter

Lead Service: 50% - 75%
Sources of Lead and Contribution to DW

- Lead plumbing
- Copper plumbing with lead solder
- Galvanized plumbing
- Brass fixtures

Faucet: 1% - 3%
Premise: 20% - 35%

Main: 3% - 15%
Lead Service: 50% - 75%
Sources of Lead- Galvanized Pipe

1. Lead bears a strong adsorptive affinity for both ferric and ferrous iron compounds, and scale formation by co-precipitation and deposition of lead-iron precipitates can potentially result in accumulation over decades of a crystalline iron corrosion scale rich in lead.

2. Lead adsorbs to galvanized iron corrosion scale; lead can persist and be mobilized to consumer taps after full replacement of lead service lines, potentially for the remaining service life of the galvanized plumbing.

3. More particulate lead was released per unit surface area of galvanized plumbing than was released from lead service lines.

4. Lead content can vary substantially in galvanized iron pipe corrosion scales depending on the history of the premise piping. A range from a few hundredths of a percent to as high as eight percent lead by weight was observed in galvanized plumbing from different homes where lead service lines have been in place.
Sources of Lead - Galvanized Pipe, cont’d

5. Lead can reside in the deepest layers of galvanized iron corrosion scales indicating the potential for continued lead release for the remaining service life of the pipes.

6. Non-iron lead minerals such as apatites, carbonates and oxides of lead can exist in isolated deposits embedded in iron corrosion scales, indicating the potential for multiple adsorptive mechanisms including physical capture that will influence scale characteristics and lead release.

7. Lead release from galvanized plumbing will likely be exacerbated substantially by physical disturbance, especially immediately following a service line replacement.

8. Lead release from galvanized plumbing can be exacerbated by hydraulic disturbances such as water hammer or increased flow velocity.

9. Lead release from galvanized plumbing that appears to have subsided to some stable level over time following physical disturbance may increase again due to subsequent disturbances.
NR 809.547 Monitoring requirements for lead and copper in tap water.

(4) TIMING OF MONITORING

d) Reduced monitoring… A water supplier shall also conduct water quality parameter monitoring in accordance with s. NR 809.548 (2), (3) or (4) during the monitoring period in which the action level was exceeded.
NR 809.547 Monitoring requirements for lead and copper in tap water.

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<table>
<thead>
<tr>
<th></th>
<th>PBCU and WQP Monitoring Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STANDARD/INITIAL MONITORING</strong></td>
<td><strong>REDUCED MONITORING (ANNUAL OR TRIENNIAL)</strong></td>
</tr>
<tr>
<td>PBCU</td>
<td>Two Consecutive 6-month sample periods</td>
</tr>
<tr>
<td></td>
<td>Jan 1 – June 30 July 1 – Dec 31</td>
</tr>
<tr>
<td>WQP</td>
<td>In the same monitoring period where ALE has occurred</td>
</tr>
<tr>
<td></td>
<td>Jan 1 – June 30 July 1 – Dec 31</td>
</tr>
</tbody>
</table>

1 Systems must collect PBCU samples at least once in every three-year period. If a system becomes eligible for triennial monitoring, they may have to collect samples at a greater frequency than triennially so that they collect at least one sample in each three-year period in accordance with the Standard Monitoring Framework (2017 Munis, 2018 OTMs, 2019 NNs).
NR 809.547 Monitoring requirements for lead and copper in tap water.  
(4) TIMING OF MONITORING  
(d) Reduced monitoring… A water supplier shall also conduct water quality parameter monitoring in accordance with s. NR 809.548 (2), (3) or (4) during the monitoring period in which the action level was exceeded.

<table>
<thead>
<tr>
<th>PBCU and WQP Monitoring Periods</th>
<th>STANDARD/INITIAL MONITORING</th>
<th>REDUCED MONITORING (ANNUAL OR TRIENNIAL)</th>
<th>SCHOOLS REDUCED (ANNUAL OR TRIENNIAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBCU</td>
<td>Two Consecutive 6-month sample periods</td>
<td>Single annual sample (annual) or one sample every 3-year period (triennial(^1))</td>
<td>Single month of reduced monitoring period when school is in session for the greatest number of days</td>
</tr>
<tr>
<td></td>
<td>Jan 1 – June 30, July 1 – Dec 31</td>
<td>June 1 – Sept 30</td>
<td>Sept 1 – Sept 30</td>
</tr>
<tr>
<td>WQP</td>
<td>In the same monitoring period where ALE has occurred</td>
<td>During designated monitoring period where ALE has occurred</td>
<td>During designated monitoring period where ALE has occurred</td>
</tr>
<tr>
<td></td>
<td>Jan 1 – June 30, July 1 – Dec 31</td>
<td>June 1 – Nov 30</td>
<td>Sept 1 – Nov 30</td>
</tr>
</tbody>
</table>

\(^1\) Systems must collect PBCU samples at least once in every three-year period. If a system becomes eligible for triennial monitoring, they may have to collect samples at a greater frequency than triennially so that they collect at least one sample in each three year period in accordance with the [Standard Monitoring Framework](https://example.com) (2017 Munis, 2018 OTMs, 2019 NNs).
<table>
<thead>
<tr>
<th>Municipal or OTM Systems</th>
<th>Non-Transient, Non-Community Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIER 1:</strong> Single family residences with:</td>
<td><strong>TIER 1:</strong> Sites where structures contain:</td>
</tr>
<tr>
<td>• Lead service lines; or</td>
<td>• Lead service lines; or</td>
</tr>
<tr>
<td>• Lead goosenecks; or</td>
<td>• Lead goosenecks; or</td>
</tr>
<tr>
<td>• Copper plumbing with lead solder constructed between January 1983 and September 1984; or</td>
<td>• Copper plumbing with lead solder constructed between January 1983 and September 1984; or</td>
</tr>
<tr>
<td>• Lead plumbing within the home</td>
<td>• Lead plumbing</td>
</tr>
<tr>
<td><strong>TIER 2:</strong> Multi-family residences or other buildings with:</td>
<td><strong>TIER 2:</strong> Sites where structures contain:</td>
</tr>
<tr>
<td>• Lead service lines; or</td>
<td>• Copper plumbing with lead solder constructed before January 1983</td>
</tr>
<tr>
<td>• Lead goosenecks; or</td>
<td><em>If you do not have enough Tier 1 and Tier 2 sites, use sites where water is typically drawn for drinking or cooking.</em></td>
</tr>
<tr>
<td>• Copper plumbing with lead solder constructed between January 1983 and September 1984; or</td>
<td></td>
</tr>
<tr>
<td>• Lead plumbing within the structure</td>
<td></td>
</tr>
<tr>
<td><strong>TIER 3:</strong> Single family residences with:</td>
<td>Not Applicable to NTNCWS</td>
</tr>
<tr>
<td>• Copper plumbing with lead solder constructed before January 1983</td>
<td></td>
</tr>
</tbody>
</table>

**EXCEPTIONAL:** Sites where plumbing materials are representative of what is commonly found at others sites served by the water system, including:

- Copper plumbing with lead solder constructed after 1984
- Tier 1, 2, or 3 sites with whole house water softeners or filters

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- Copper plumbing with lead solder constructed after 1984
- Tier 1, 2, or 3 sites with whole system water softeners or filters

*DO NOT* use Exceptional sites unless they are the only sites available for testing.
SAMPLE TAP CRITERIA

- Cold water taps
- Taps within the interior of a residence of other building
- Taps where water is used for human consumption
- Taps where water is untreated by softening or filters
- Taps where water is used on a regular basis

<table>
<thead>
<tr>
<th>Examples of VALID Taps</th>
<th>Examples of INVALID Taps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen Sink Cold Water Taps</td>
<td>Hot Water Taps</td>
</tr>
<tr>
<td>Bathroom Sink Cold Water Taps</td>
<td>Exterior Taps or Hose Bibs</td>
</tr>
<tr>
<td>Break Room Sink Cold Water Taps</td>
<td>Pressure Tank Taps</td>
</tr>
<tr>
<td>Drinking Water Fountains/Bubblers</td>
<td>Laundry Sinks or Eye Wash Stations</td>
</tr>
<tr>
<td>Kitchenette Taps (or other food preparation areas)</td>
<td>Vacant Apartment/Condo/Hospital Room Taps</td>
</tr>
</tbody>
</table>

SAMPLING DO’S AND DON’Ts

**SAMPLING DO’S**

- Sample during the appropriate monitoring period
  - Standard Monitoring: Jan 1 – June 30 and July 1 – Dec 31
  - Reduced (Annual or Triennial Monitoring): June 1 – September 30
  - Schools (Annual or Triennial Monitoring): September 1 – September 30

- **SAMPLE EARLY!** Give yourself time to re-sample if you have issues with shipping or lab procedures or need to take corrective actions (systems with lead and copper Action Level exceedances will be required to collect water quality parameter samples in the same monitoring period).

- Collect samples at the same location as all previous sampling events in accordance with your SITE MONITORING PLAN (contact your DNR Rep if you need to adjust your system's monitoring sites).

- Collect first-draw samples (water is to have stood motionless for at least six hours).

- Collect samples in 1-liter wide-mouth sample containers.

- When samples are sent to the laboratory for analysis, make sure that all sections of the lead and copper sample form are completed and the form is included with your lab sample. This includes clearly noting the date and time the sample was collected, sample ID, the address, and the location (second floor) and tap description (bathroom cold water tap) where the sample was collected.

**SAMPLING DON’Ts**

- **DO NOT** pre-flush the tap prior to the stagnation period (six hours) or prior to collecting the sample.
- **DO NOT** remove the aerator prior to sampling.
- **DO NOT** collect samples from taps where water has remained motionless for significantly longer than 6-hours (i.e. vacant properties, schools over break periods).
- **DO NOT** use a tap that is downstream of a filter or softener.
Assessing Efficacy of Treatment

- First draw 1 L sampling inadequate in assessing true lead exposure
- Improper site selection for LCR sampling
  - Tier 2 and Tier 3 sites chosen over Tier 1 sites
  - Inadequate records of LSL infrastructure

The red dashed box approximates what is captured by one 1-liter sample
Assessing Efficacy of Treatment

• First draw 1 L sampling inadequate in assessing true lead exposure

• Improper site selection for LCR sampling
  ✓ Tier 2 and Tier 3 sites chosen over Tier 1 sites
  ✓ Inadequate records of LSL infrastructure
Assessing Efficacy of Treatment

Pb levels - 11th liter
50 ug/L

Pb levels - 1st Liter
12 ug/L

Ph Adjustment
(Orthophosphate Addition In March)
Assessing Efficacy of Treatment

Lead levels 1.5 yrs after ortho start

Pb levels - 9th liter
32 ug/L
Assessing Efficacy of Treatment

- **pH Adjust**: Started Jan 2016
- **Lead Levels**: Two years after Start of Orthophosphate
- **Orthophosphate**: Started March 2016
Assessing Efficacy of Treatment

We Know...

Lead and copper in drinking water can be 4-8 times higher than what first-draw sample values demonstrate.
Assessing Efficacy of Treatment

Optimal Corrosion Control
Treatment Evaluation Technical
Recommendations for Primacy
Agnecies and Public Water Systems

MARCH 2016
Assessing Efficacy of Treatment

Many different water quality (WQ) conditions can impact Pb and Cu release and need to be considered.
Alkalinity, pH, DIC, corrosion inhibitors, and ORP (in certain types of waters) remain critical parameters that directly impact lead release.
Treatment Options

CCT SCIENCE

- Was CCT selected to reduce lead and/or copper levels?
- Is CCT dosed at a rate that will effectively reduce lead and/or copper levels to the greatest extent practical?
- Was CCT selected to work in combination with another treatment goal (i.e. sequestration)? Are the technologies competing with each other? With other water quality factors?
- If using blended phosphates, is the addition of excess polyphosphate sequestering lead and copper?
Treatment Options

ORTHOPHOSPHATE

- Systems should target distribution system orthophosphate residuals of 1-3 mg/L or as high as 3-6 mg/L where systems have LSLs

- Lead levels may continue to decline for years after optimal ortho doses have been applied due to slow rate of scale formation (passivation dose vs. maintenance dose)

- Blended phosphates can add excess polyphosphate to systems and sequester lead and copper

EPA OCCT Guidance – March 2016
<table>
<thead>
<tr>
<th>Status</th>
<th>DS Ortho (mg/L)</th>
<th># Systems</th>
<th>Totals</th>
<th>Percent Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Likely Optimized</td>
<td>0.0-0.30</td>
<td>19</td>
<td>163</td>
<td>65.5</td>
</tr>
<tr>
<td></td>
<td>0.31-0.60</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.61-0.9</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.91-1.2</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maybe Optimized</td>
<td>1.21-1.5</td>
<td>27</td>
<td>60</td>
<td>24.1</td>
</tr>
<tr>
<td></td>
<td>1.51-2.0</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likely Optimized</td>
<td>2.01-2.5</td>
<td>20</td>
<td>26</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td>2.51-3.0</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Systems</td>
<td>249</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For systems with LSLs*
Treatment Options

THEORETICAL FORMATION OF Pb(II) ORTHOPHOSPHATE SOLIDS

High doses in excess of 20 mg/L may be required to control lead release.

Start-up dose of 24 mg/L is recommended; eventual maintenance does of 8-12 mg/L (maybe???)

Silicates can raise pH.

Silicates can also sequester where Fe and Mn are <1 mg/L.

Chloride, calcium, and Mn can affect optimum dose.

Lack of research and field information proving its effectiveness.
<table>
<thead>
<tr>
<th>Status</th>
<th>EP Silicate (mg/L)</th>
<th>No of Systems</th>
<th>Totals</th>
<th>Percent Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Likely Optimized</td>
<td>0-2.49</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5-7.49</td>
<td>1</td>
<td>7</td>
<td>63.6</td>
</tr>
<tr>
<td></td>
<td>7.5-14.99</td>
<td>5</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Maybe Optimized</td>
<td>15.0-19.99</td>
<td>1</td>
<td>2</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>20-24.99</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likely Optimized</td>
<td>25.0-29.99</td>
<td>1</td>
<td>2</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>&gt;30.0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For systems with LSLs*
Treatment Options

pH Adjustment

• Target pH should be **8.8 to 10**.

• **Systems with lead service lines** that are not using a corrosion inhibitor should consider increasing the pH to **9.0 or greater**.

• **Lower pH values**, particularly between **8.2 and 8.5**, can result in poor buffer intensity of the water (regardless of DIC levels) and wide swings in distribution system pH.

EPA OCCT Guidance – March 2016
<table>
<thead>
<tr>
<th>Status</th>
<th>pH (SU)</th>
<th># Systems</th>
<th>Totals</th>
<th>Percent Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Likely Optimized</td>
<td>&lt; 6.99</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.00 – 7.50</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.51 – 7.99</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.00 – 8.50</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.51 – 8.79</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likely Optimized</td>
<td>8.80 – 9.00</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 9.01</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Systems</td>
<td></td>
<td>107</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For systems with LSLs*
Conclusions

1) “Passing” Lead and copper sampling is not an indication that lead and copper exposures have been minimized or that CCT is optimized.

2) First draw samples ≠ peak lead levels. Peak lead levels can be up to 4-8 times higher.

3) Corrosion Control Treatment targets tailored to 90\textsuperscript{th} percentile values are not necessarily optimized.

4) Treatments must be tailored to the source of lead and/or copper present in a given community (i.e. LSLs vs. fixtures)