Presentation to the EPA SAB on Lead Service line Replacement

Lead Service Line Replacement – The New/Old Controversy

PLSLs : Are they effective? Do they make the situation worse? Is galvanic action a public health threat? PLSLs and OCCT

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A short review of sponsored research on issues related to PLSL galvanic action and lead release.

References/Acknowledgements

Materials that may not have been included in the SAB document package

- DC Water, An Analysis of the Correlation between Lead Released from Galvanized Iron Piping and the Contents of Lead in Drinking Water - Final Report and Appendices, 2009
- WRF 3107, Effect of Changing Disinfectants on Distribution System Lead and Copper Release – Part 2, 2010
- WRF 3118, Assessment of Inorganics Accumulation in Drinking Water System Scales and Sediments, 2010
- Boyd et.al., Galvanic Coupling Effects with Changing Water Quality, WQTC 2010
- Boyd et.al., Lead in Tap Water Following Simulated Partial Lead Pipe Replacements, ASCE 2004
- Yu-Peng et.al., Occurrence of Trace Inorganic Contaminants in Corrosion Scales and Deposits formed in Drinking Water Distribution Systems, In-Press
- DeSantis et.al., Mineralogical Evidence of Galvanic Corrosion in Domestic Drinking Water Pipes, WQTC 2009

Take Away Points

- The DC epidemiologic data (BLL association with LSLs and PLSLs) developed 1998-2006 is not indicative of a stable distribution system with optimized corrosion control.

- LCR compliance sampling is the worst possible approach to determining lead exposure, except for all the others. *Despite the vagaries of lead monitoring, it remains useful for determining OCCT, which was its intended use.*

- Lead at the tap is not just a function of LSLs, PLSLRs, Solder or Brass. Lead accumulates on all plumbing surfaces (especially iron) and is present in particulate form in meaningful quantities across virtually all distribution systems.

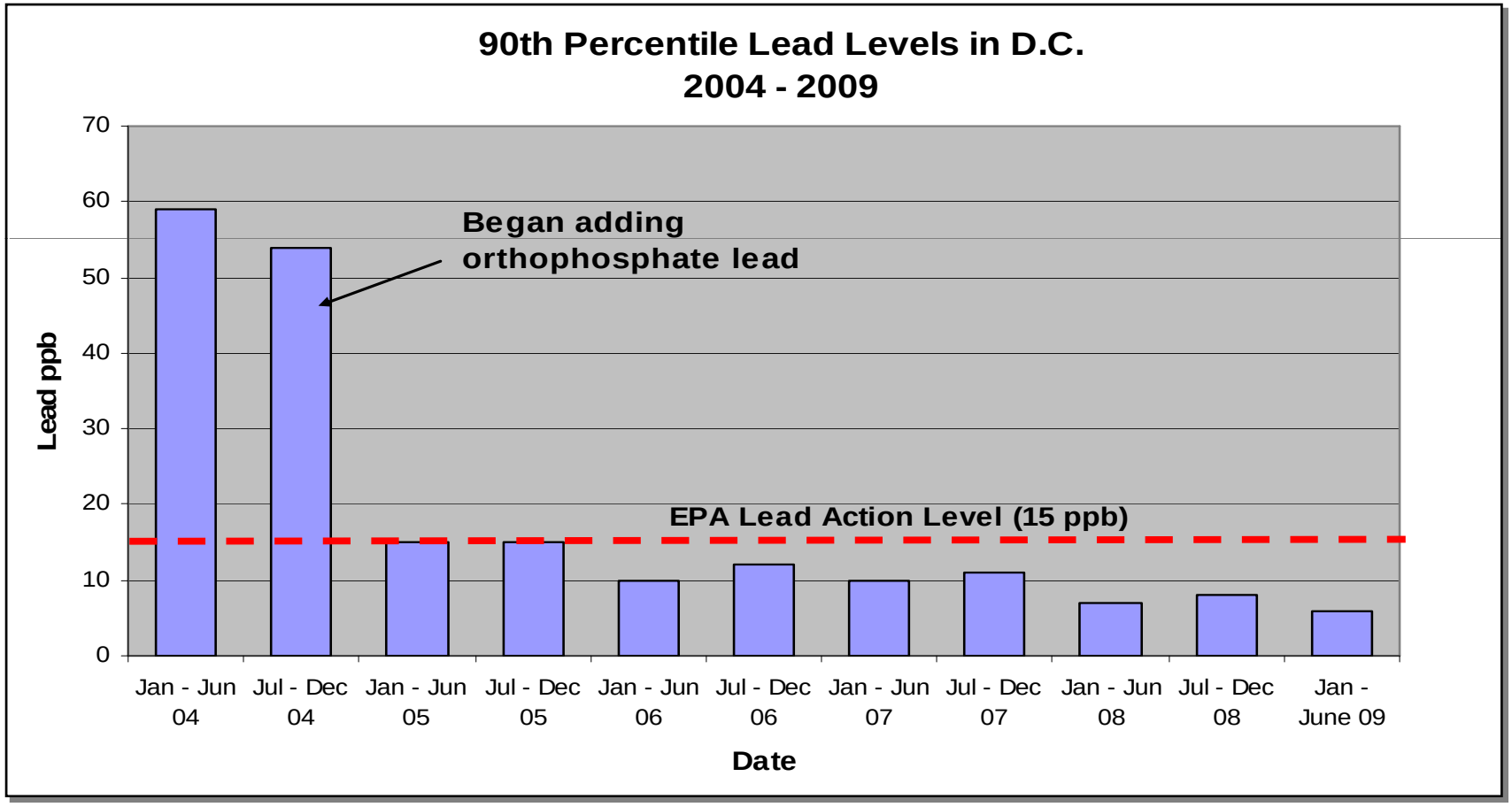
- Dielectric couplings (PLSLR) are inapprpriate. *The issue is not cost, it's homeowner safety and electrical code compliance.*

- A passivated PLSLR is no more significant than a single solder sweated joint.

- Galvanic action is largely a function of cell geometry and irrelevant to a PLSLR. *The electrochemical explanation is both straightforward and subtle.*

DC Lead Levels: Then and Now

Conditions existing in 2003 are not reflective of current drinking water lead levels. Although the BLL and drinking water lead relationship was unclear in 2003, there is likely minimal association in 2011.

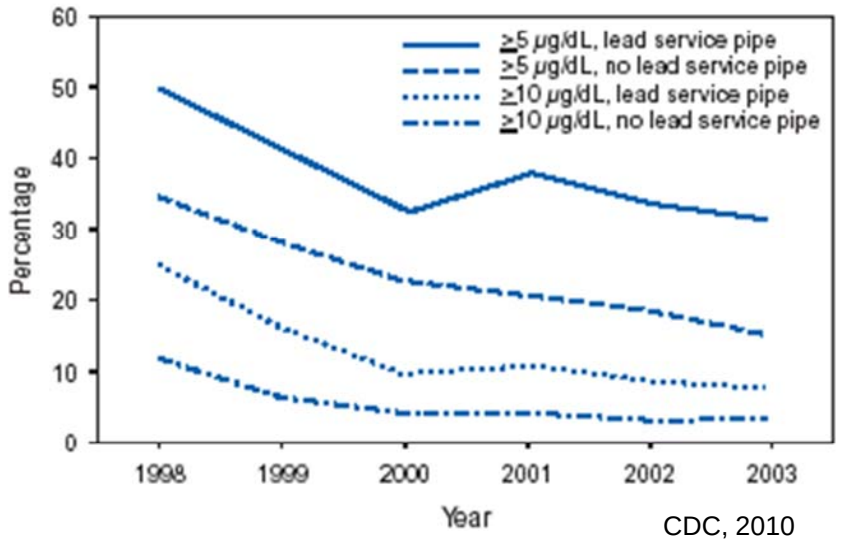


The DC System was not truly stabilized until 2008.

DC drinking water lead levels continue to decrease

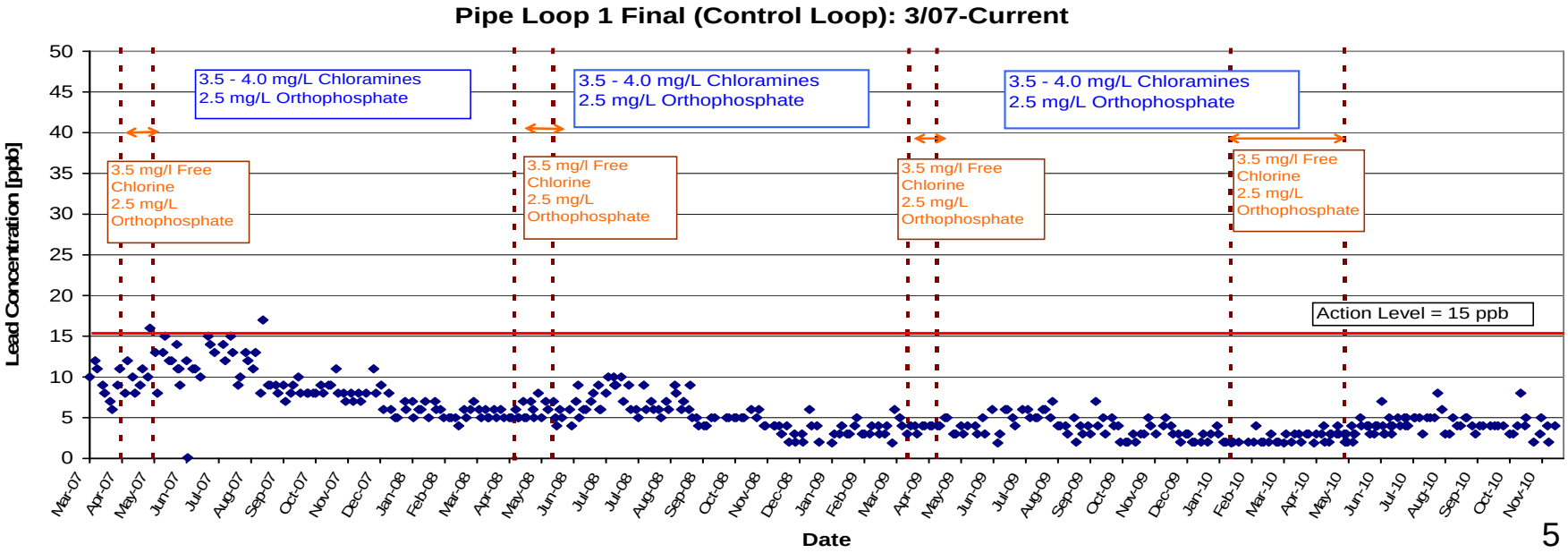
The specific issues that created the “lead crisis” have been resolved (Pb solubility driven by redox conditions).

FIGURE. Percentage of tests with elevated blood lead levels, by year and water-line type — District of Columbia, January 1998–September 2003



CDC, 2010

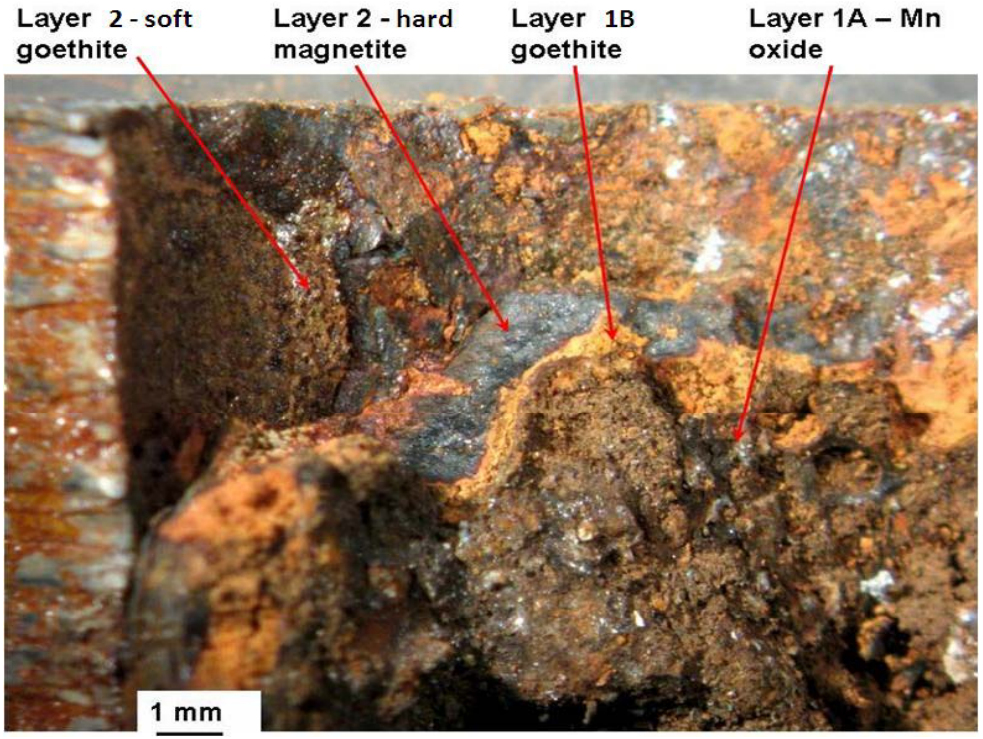
Ongoing lead release monitoring, DC Water



Tracking the source(s) of drinking water lead is not straightforward

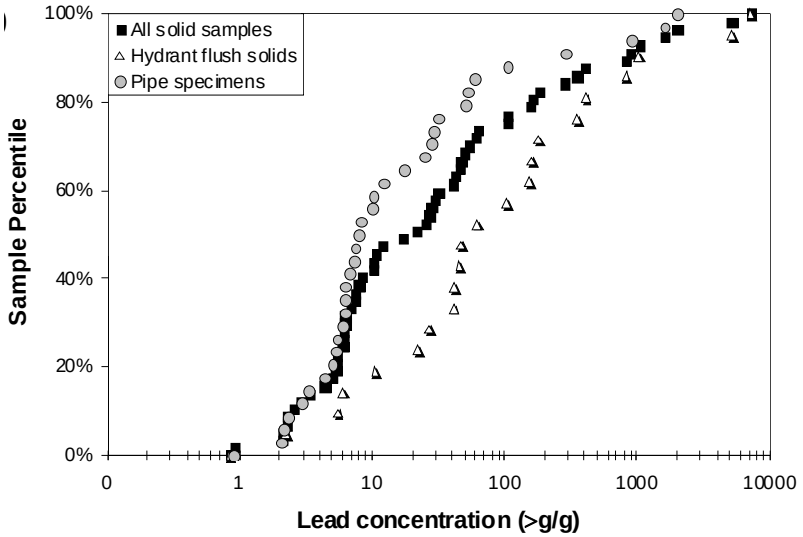
Particulate lead comes from multiple sources including LSLs.

In older homes iron scales are an important reservoir of Lead



University of Cincinnati Department Of Geology

Sediment samples from 27 utilities



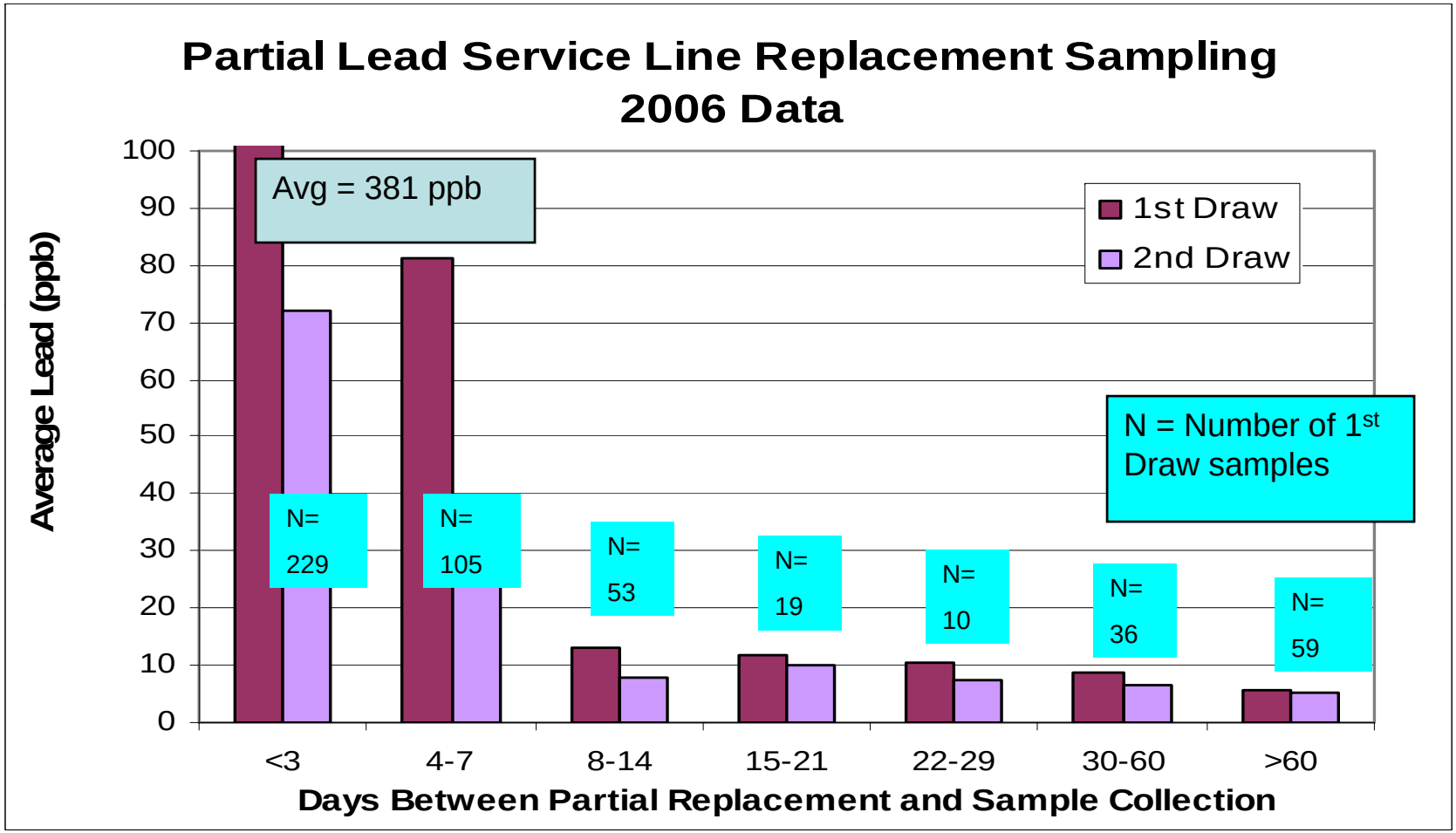
Distribution system sediments are also a significant source of lead. (WRF 3118, 2010)

- Substantial variation in lead content observed from site to site
- Range of lead content from hundredths of a percent in some homes to as high as 8% in another
- High lead content observed even in deepest layers of iron scale

DC Water, Galvanized Pipe Study, 2010

An Abundance of Evidence Demonstrates the Temporary Nature of Lead Release Associated with PLSLR

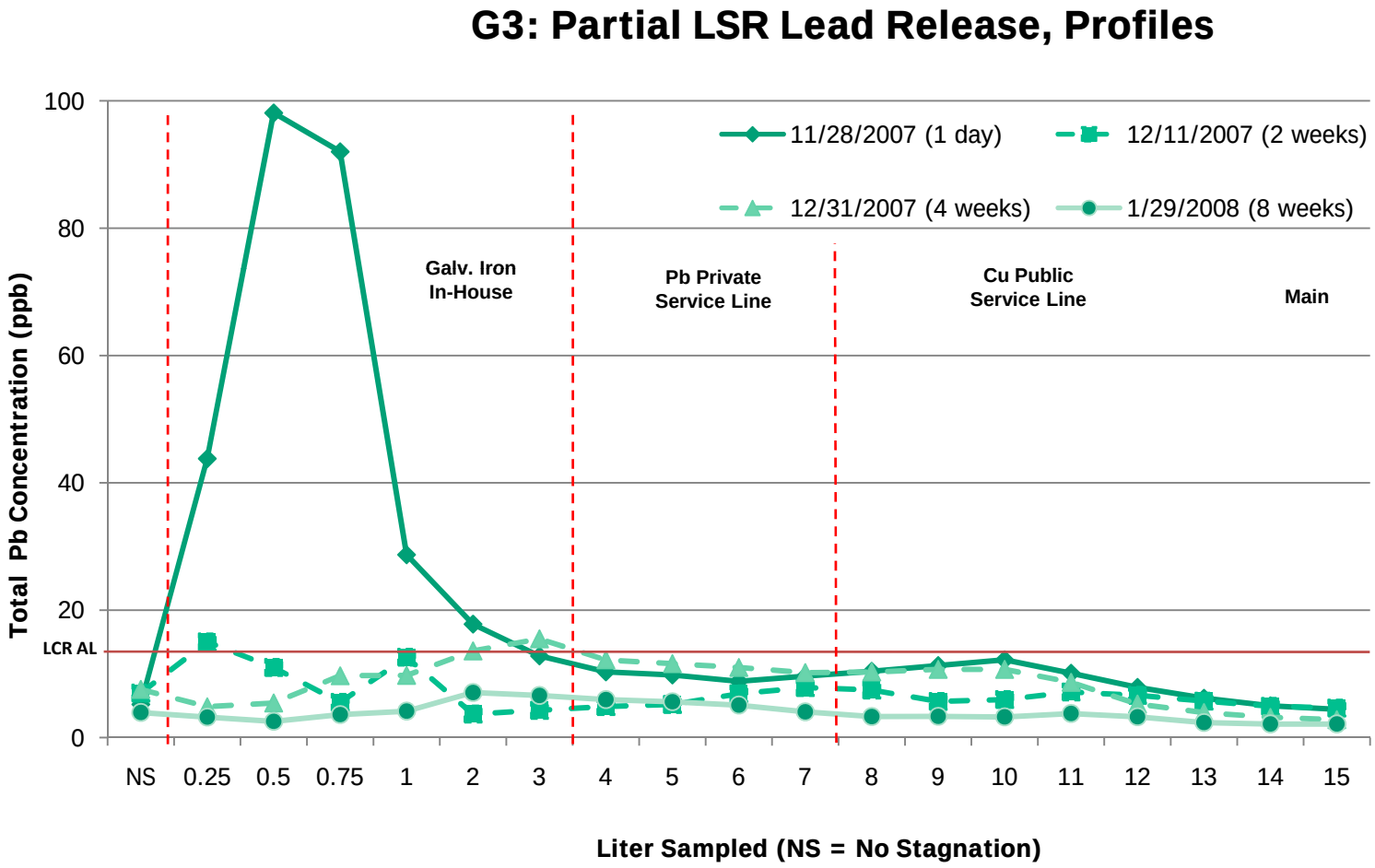
Lead Levels After DC PLSRs



2008 re-sampling of 75 PLSLR homes show 90th percentile first draw Pb level of 12 ppb

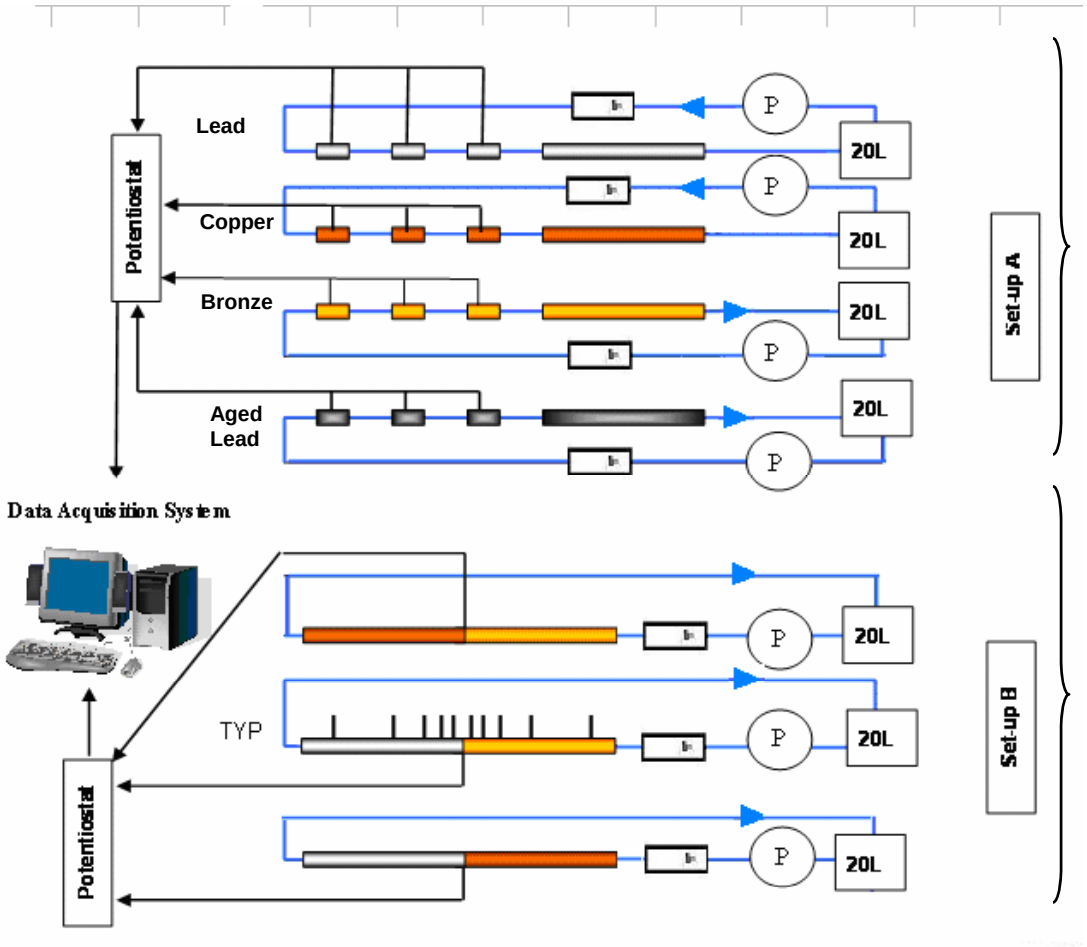
DC Water, 2009

Extensive Whole House Profiling Immediately Following a PLSLR Show no Meaningful Galvanic Impact



DC Water, Galvanized Pipe Study Appendices, 2010

Direct Comparisons of LSL versus PLSR Lead Release under Varying Water Quality Conditions: Laboratory Pipe Loop Testing (WRF 3107)

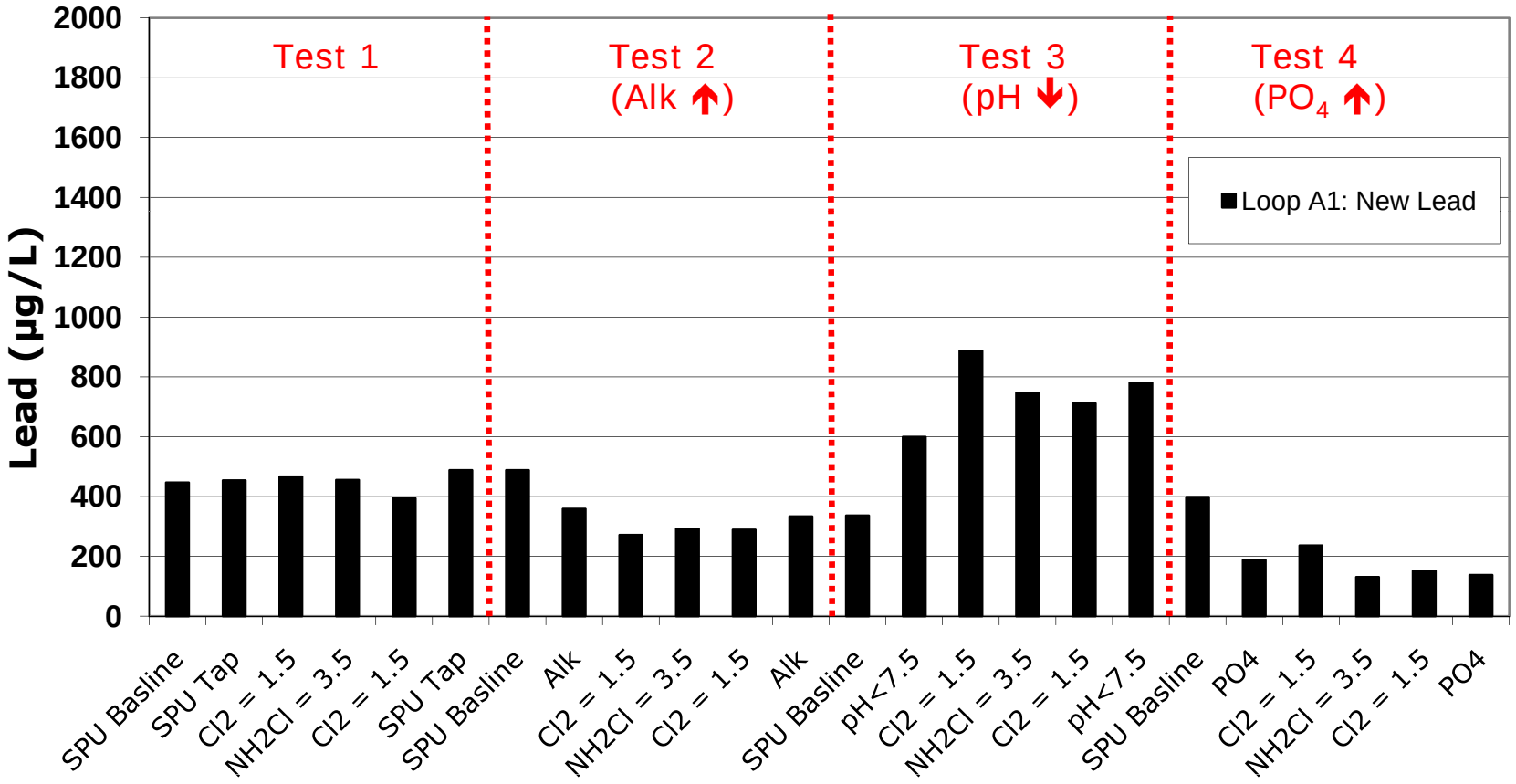


Single metal pipe loop (new lead, copper, bronze, & aged lead)

Seattle Water

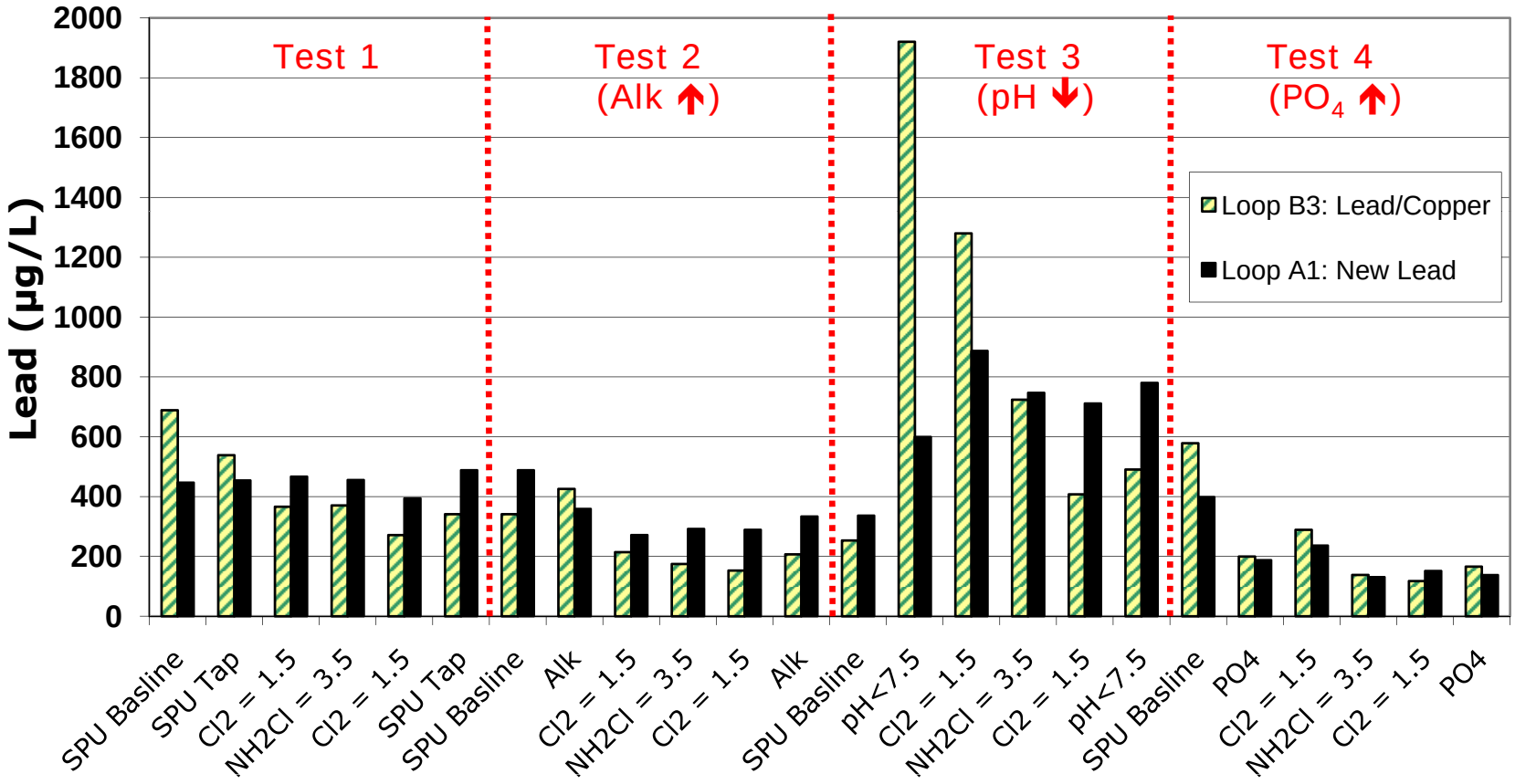
Galvanic couplings

Results: Lead Release on Single-Metal (non-coupled) Lead Pipe with Alternating Disinfectants



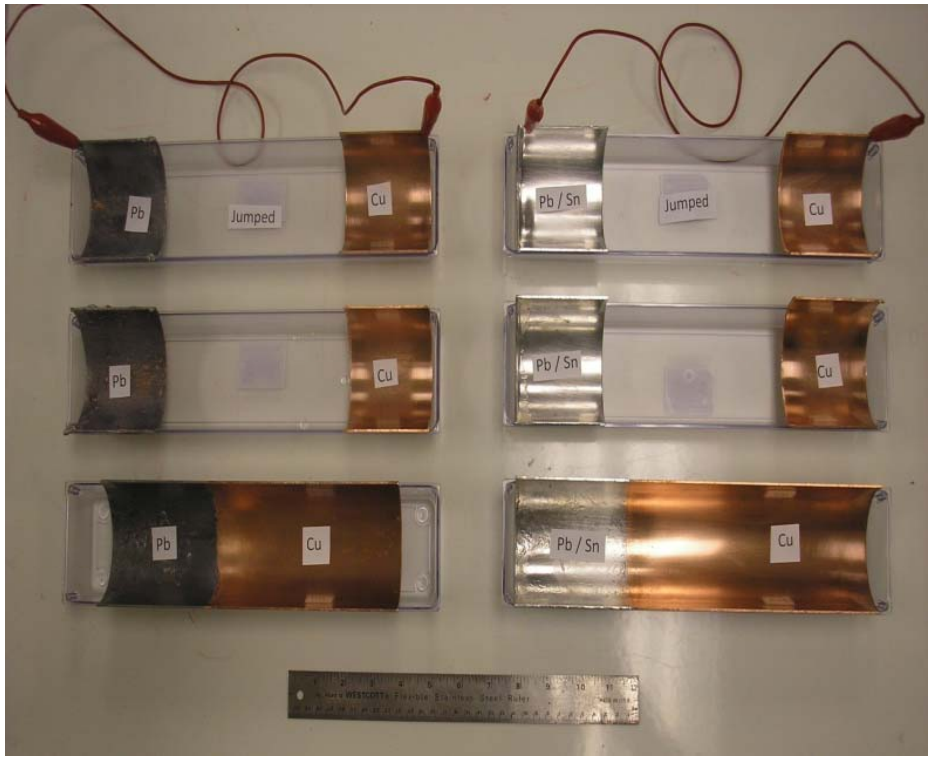
Average seventh-day lead measured in samples collected from new lead pipe loop (A1)

Results: Galvanic-Couple Pb-Cu vs. Single-Metal Lead Release with Alternating Disinfectants



Comparison of average seventh-day lead samples

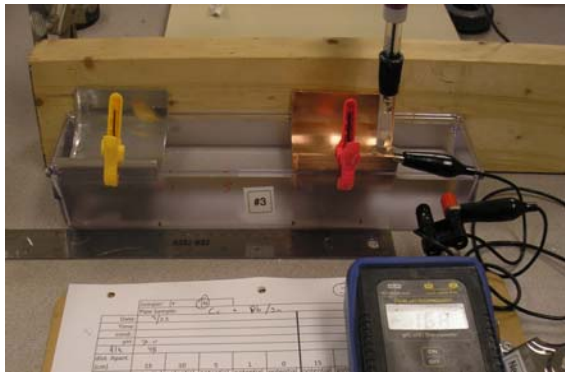
Ongoing Electrochemical Studies: Cell Geometries and Current Path Determine the Nature and Extent of Galvanic Action



Objective

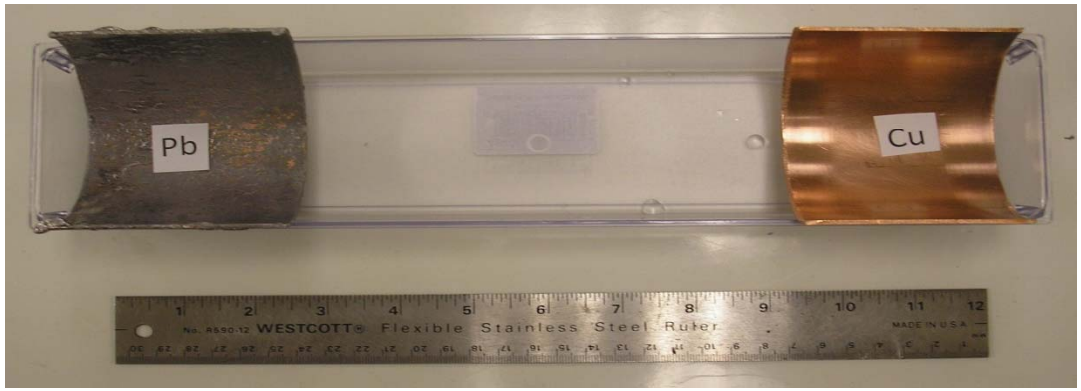
Compare potential profiles for lead and copper surfaces

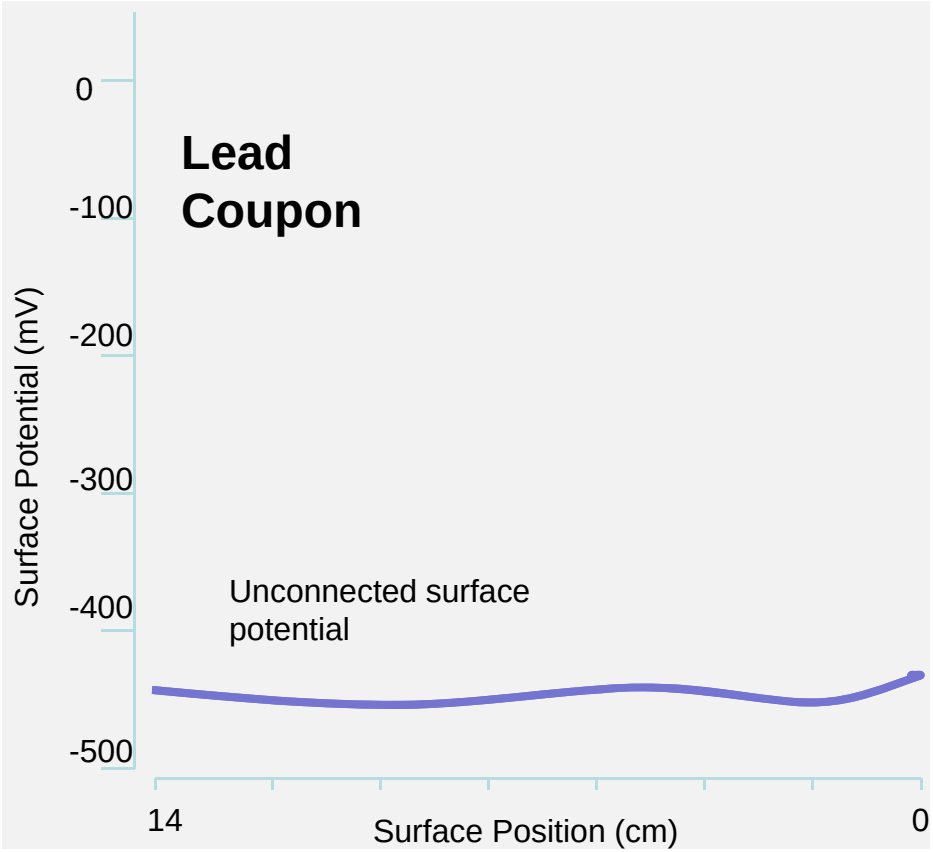
1. **Jumpered (wired) metals**
2. **Independent metals**
3. **Jointed (end-to-end) metals**

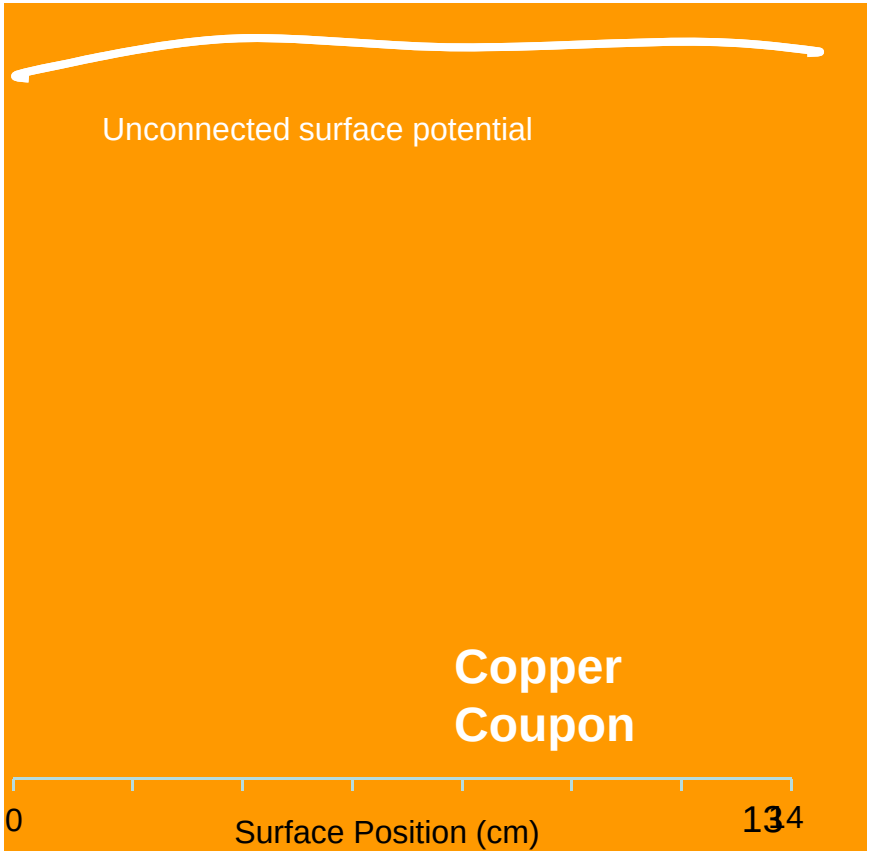


Independent Coupons

- **Well defined and stable electrochemical surface potentials**

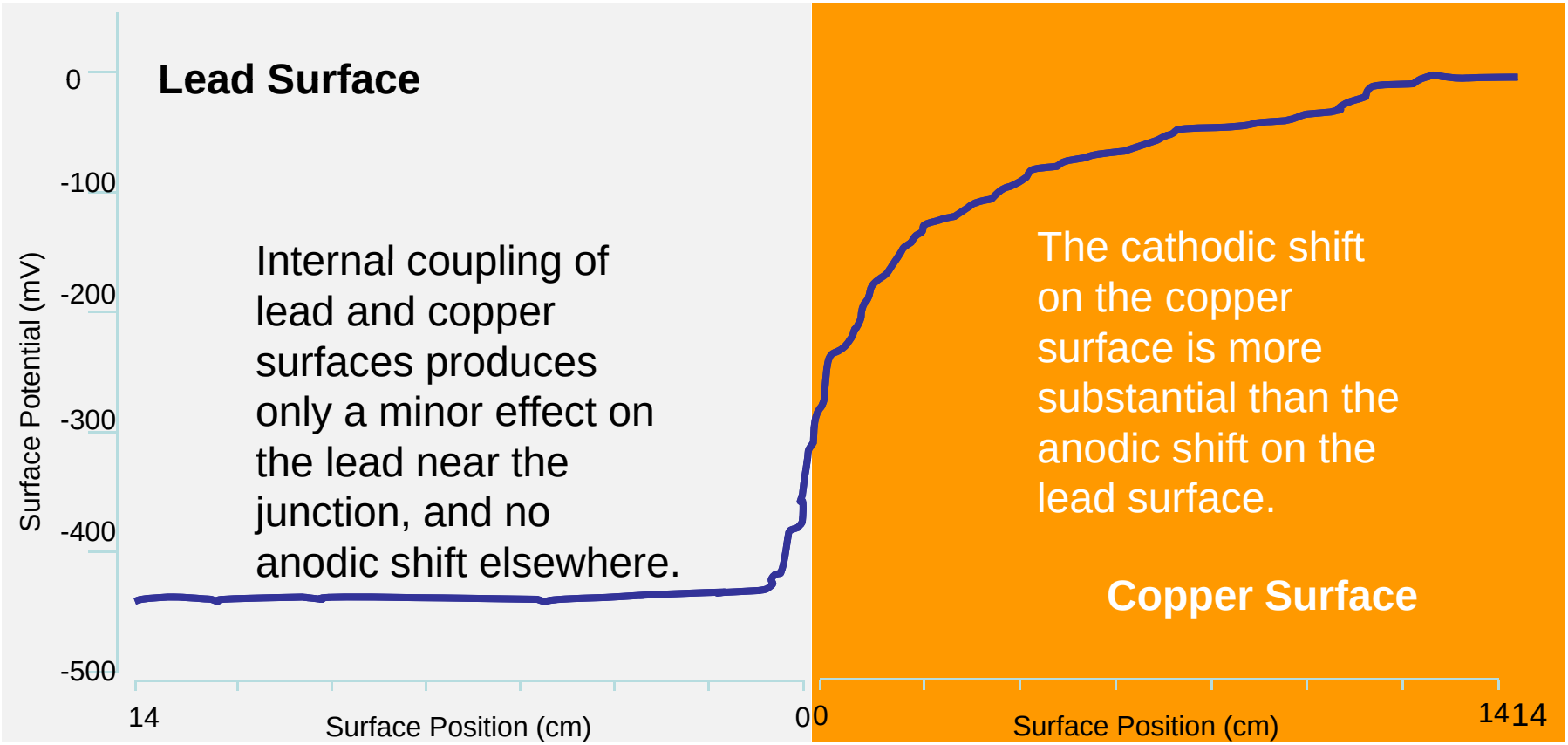






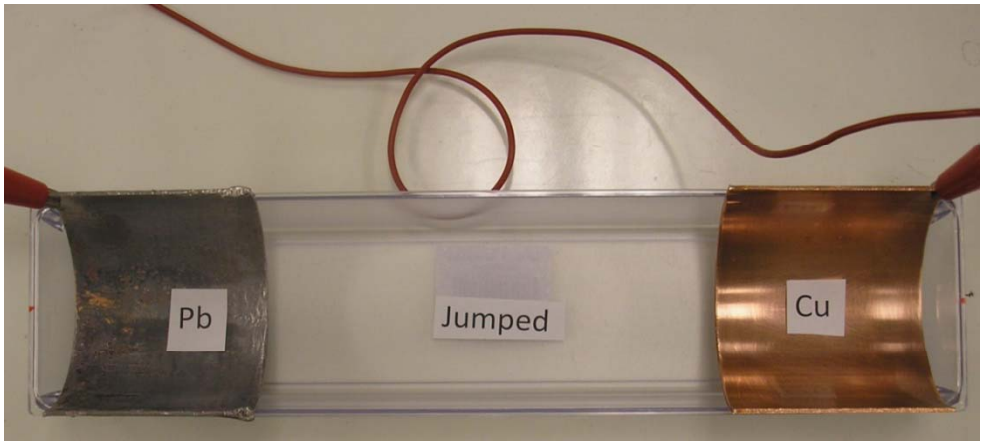
Jointed (End-to-End) Coupons

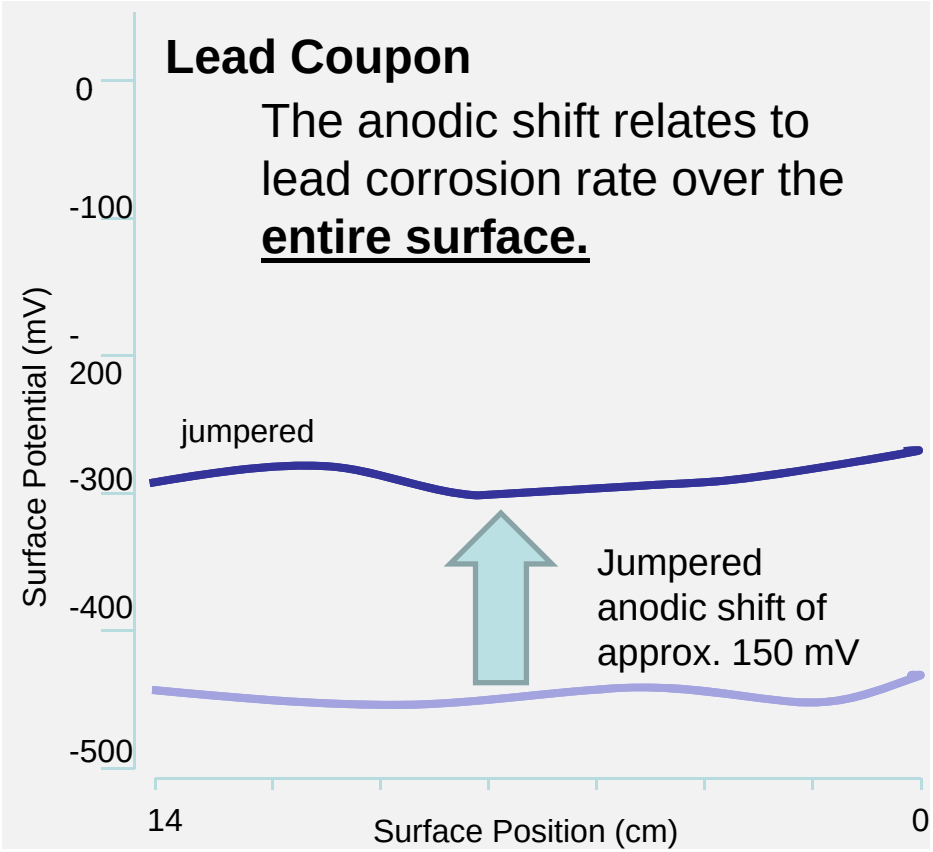
- **Produces a minor increase in corrosion on the lead surface**

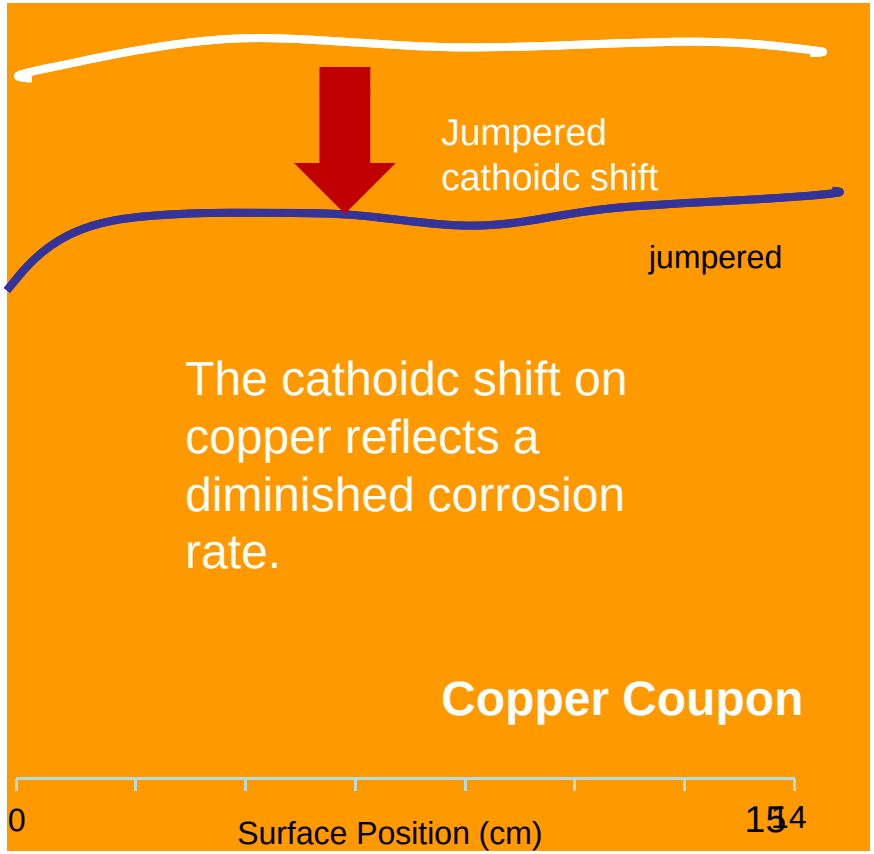


Jumpered (Wired) Coupons

- **Anodic/cathodic shifts extend over the entire surfaces**
- **Shifts are substantial and reflect a meaningful lead corrosion increase**

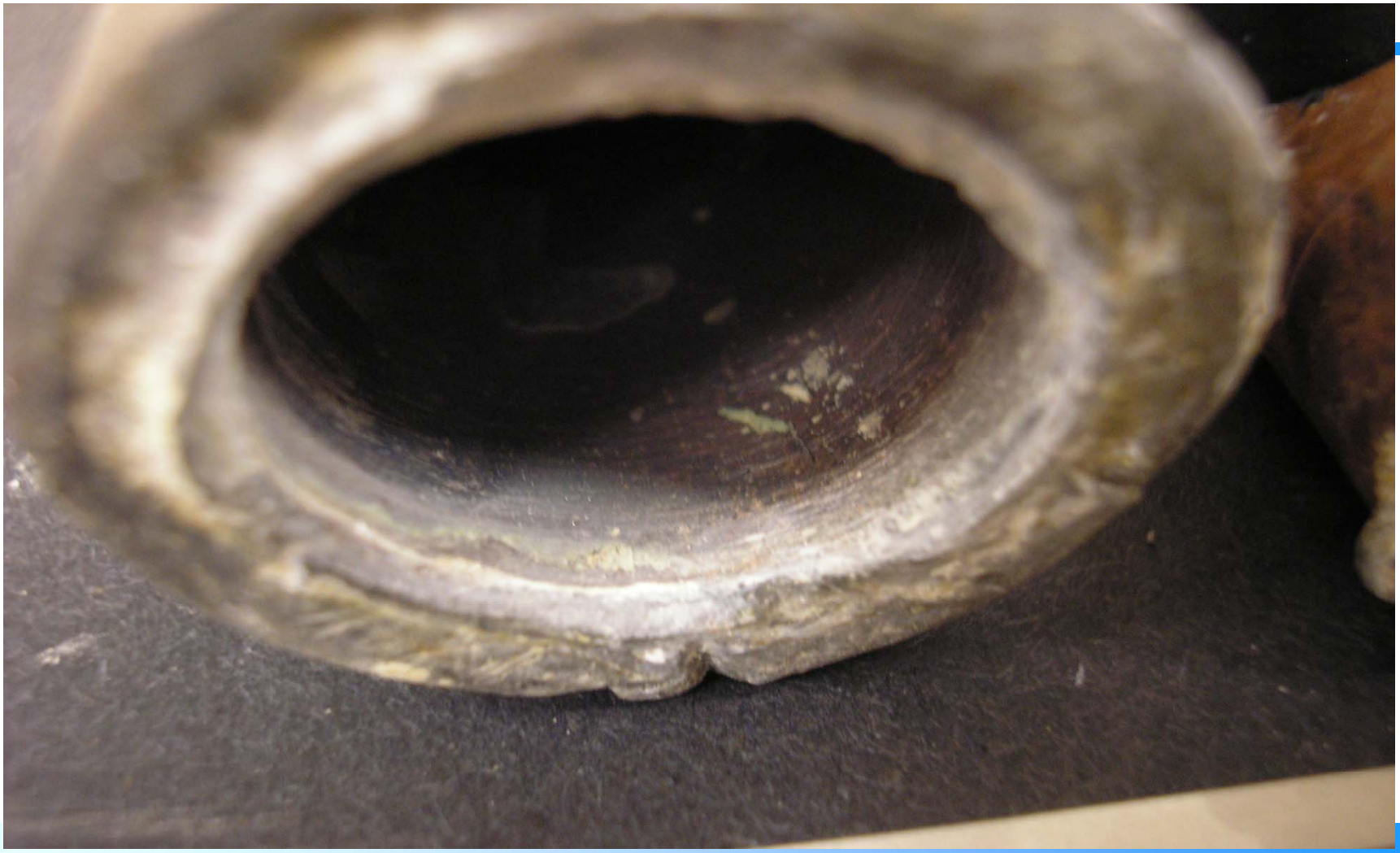




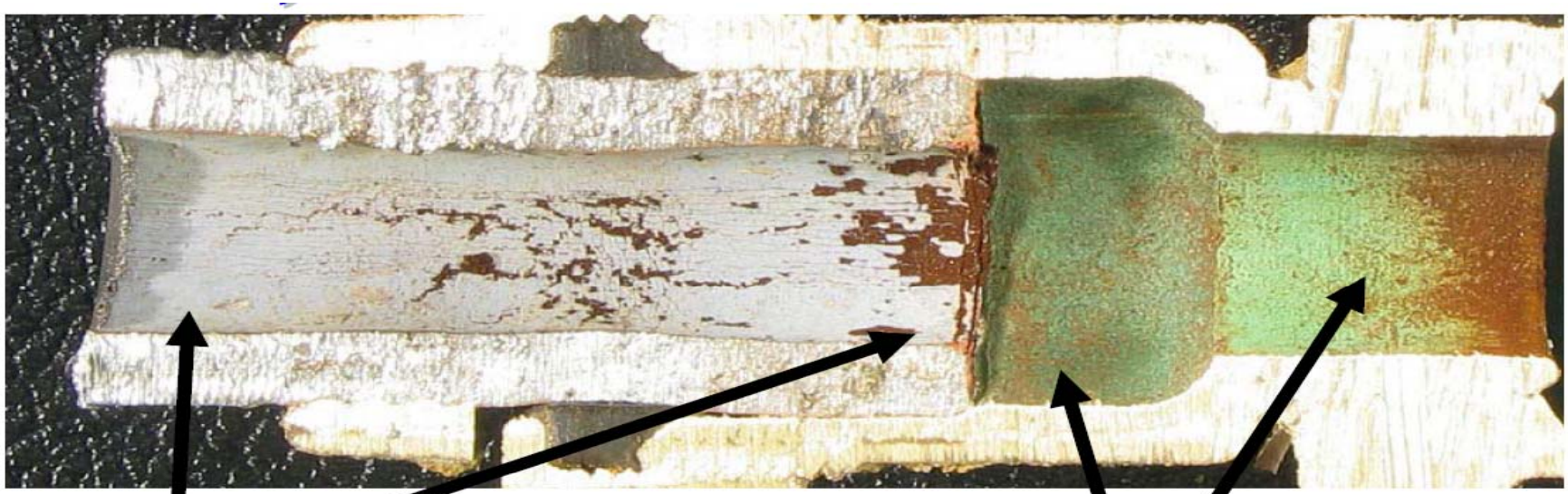


Galvanic Couple Separated after One Year of Testing

Area of Galvanic Influence on LSL Extremely limited – No More Significant than a Solder Sweated Joint



Existing PLSLs – 60 Years of Service and No Evidence of Accelerated Corrosion



Plattnerite – PbO_2
Cerussite – $PbCO_3$
Hydrocerussite – $Pb_3(CO_3)_2(OH)_2$

Malachite – $Cu_2(CO_3)(OH)_2$

Disantis, 2009

Millions of these joints remain in service nationwide.

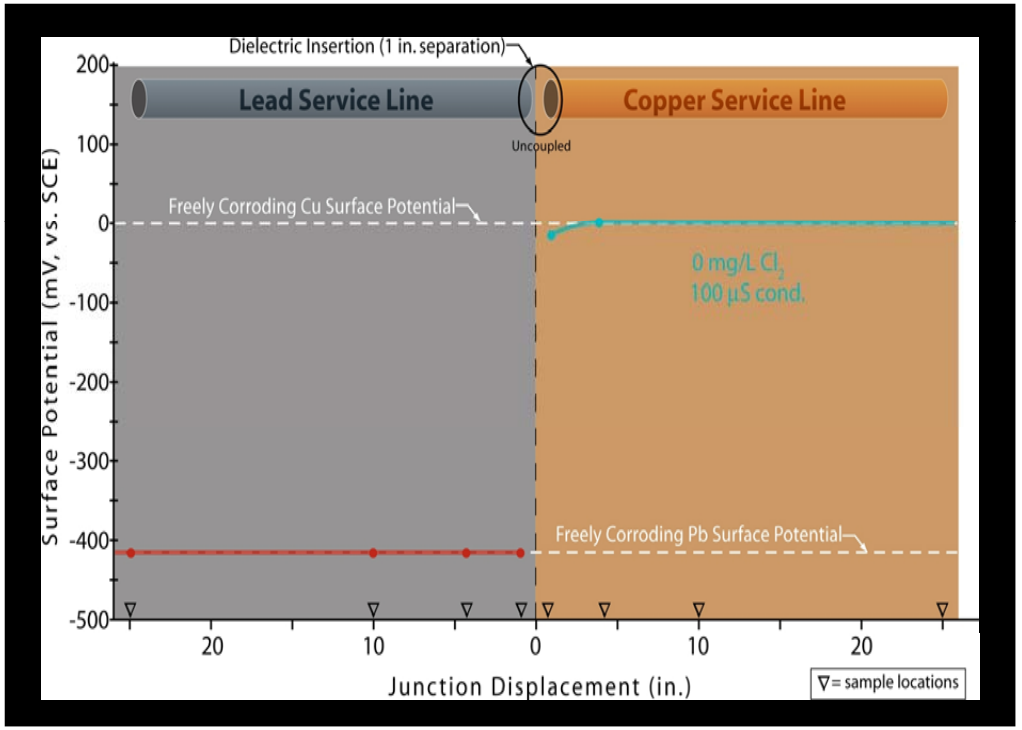
Are the Use of Dielectrics on PLSLs Warranted?

The Issue is not cost or effectiveness, it's homeowner safety and electrical code compliance

Insertion of a dielectric essentially removes any trace of potential galvanic action

It has been standard practice throughout the US for household electrical systems to utilize a ground path via the buried water line as a safety measure - This is required by the National Electrical Code (adopted by many local governments).

International Plumbing Code (2000) – "Existing metallic water service pipe used for electrical grounding shall not be replaced with nonmetallic pipe or tubing until other approved means of ground are provided."

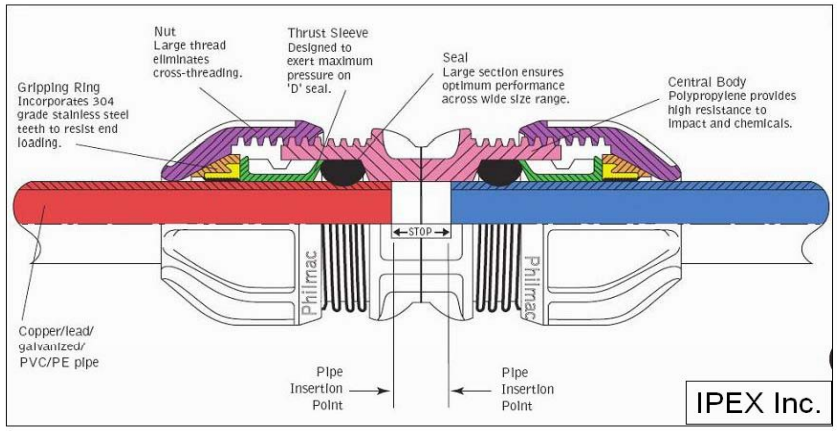


Testing under controlled laboratory conditions, HDR 2006

DC PLSLR Experience: Almost All PLSLR Candidate Homes (by Virtue of Age) Use the Service Line as the Sole Electrical Ground

In approximately 40% of the DC PLSLR homes the private side service length is less than 3 meters.

Installation of a dielectric on a LSL with less than 3 M of private side service requires the utility to install a separate grounding electrode at an additional cost of $500-1000. By Law, this cost must be conveyed to the homeowner and generates serious liability issues for the utility.



Conventional dielectrics are inadequate for LSL application – a specialized all plastic coupling is required

What has been Learned?

- Water treatment continues to be an effective method of reducing lead levels in service lines
- Full LSR is an effective method of reducing lead at the tap by:
  - Removal of a direct source of lead released into the water
  - Removal of a lead seeding source to downstream piping and appurtenances.
- Impact of partial lead service line replacements in reducing lead levels at the tap vary by home.
  - Some homes observe a temporary increase in lead levels immediately after a partial replacement.
  - Research shows that increase typically lasts for less than 2 weeks.
- Galvanized plumbing may be a contributory factor to elevated lead levels in some homes but more research on a local and national level is needed.