WRF 5081

Guidance for Using Pipe Rigs to Inform Lead and Copper Corrosion Control Treatment Decisions – Program Drivers

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WRF #5081 Guidance for Using Pipe Rigs to Inform Lead and Copper Corrosion Control Treatment Decisions

17 Utilities!

Alan Roberson

Vernon Snoeyink

Discussion Topics

1. Research Project Objective
2. Overview of Guidance Manual and Deliverables
3. Drivers for Conducting Pipe Rig Studies and Associated Impacts

Research Project Objectives

Research Objective

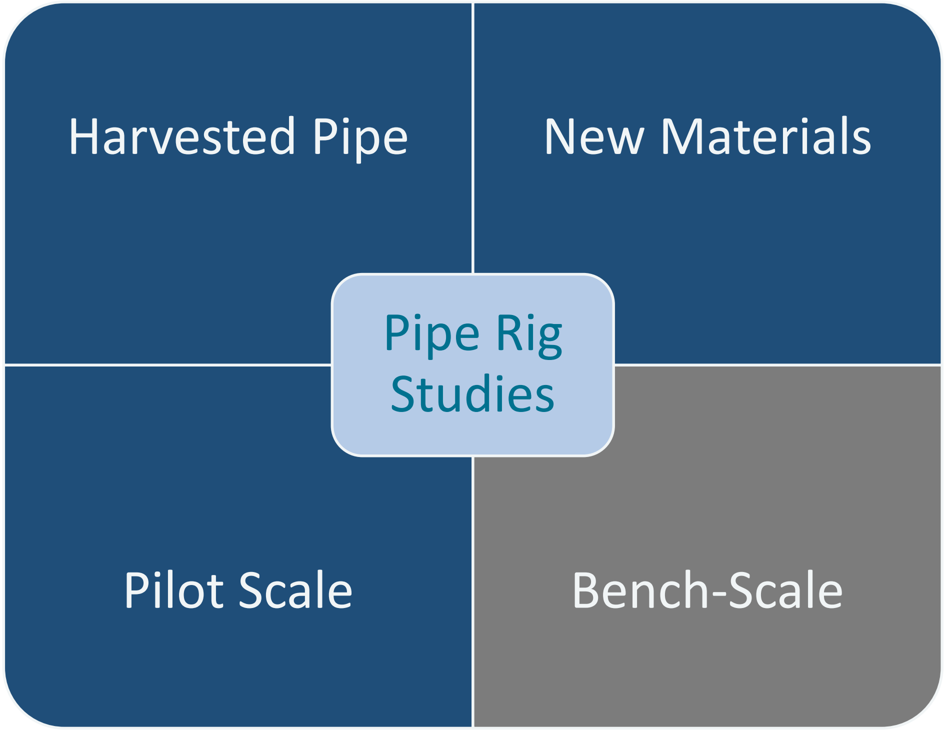
Develop a “fit-for-purpose" guidance document describing how to:

- Plan, construct, and operate pipe rigs (including costs)
- Interpret the results
- Inform water systems on lead and copper CCT decisions and to meet system-specific goals

Updated guidance is needed for compliance with new requirements under the Lead and Copper Rule Revisions (LCRR) and to effectively support voluntary studies

Scope of WRF 5081 Guidance

- Focuses on flow-through studies using harvested and new test materials
  - Under LCRR, harvested pipe rig study required for systems with lead service lines (LSLs) that exceed action level
- Does not cover static/fill and dump bench-scale tests
  - Under LCRR, bench-scale coupon tests are allowed for screening purposes only



Great Lakes Water Authority (GLWA) Rig Test Piece Materials

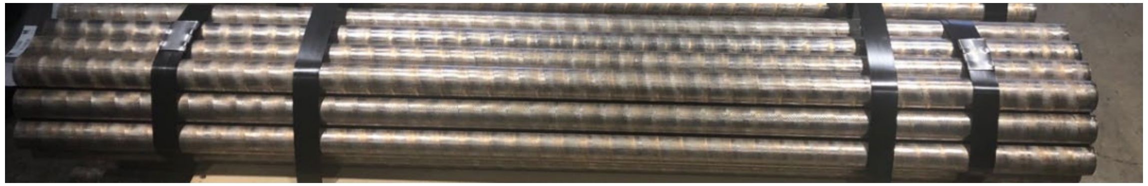
- Harvested Lead

- Harvested galvanized previously connected to lead

- New copper

- Copper with leaded solder (manufactured)

- Brass fixtures (custom cast)



Source: Hogue and Slabaugh, WQTC 2022

Ten Test Locations x Four Test Conditions (rigs) per location = 40 rigs and 400 Test Pieces!

Many Pipe Rig Shapes and Sizes

Overview of Guidance Manual and Deliverables

Guidance Manual Overview

Table of Contents

- Glossary

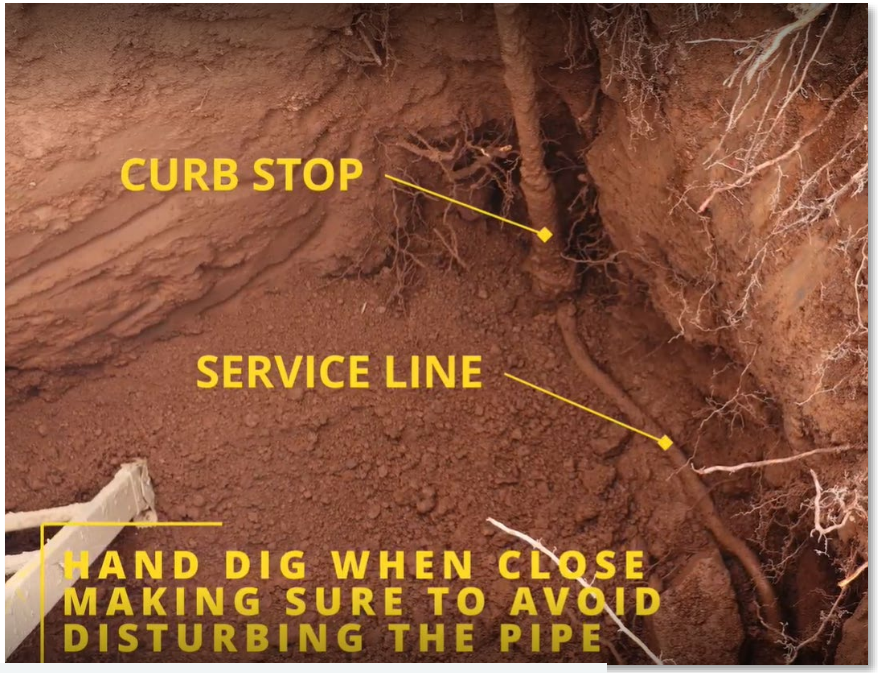
1. Introduction
2. Drivers
3. Design
4. Operations
5. Data Analysis
6. Costs

Multi-Media Supporting Materials

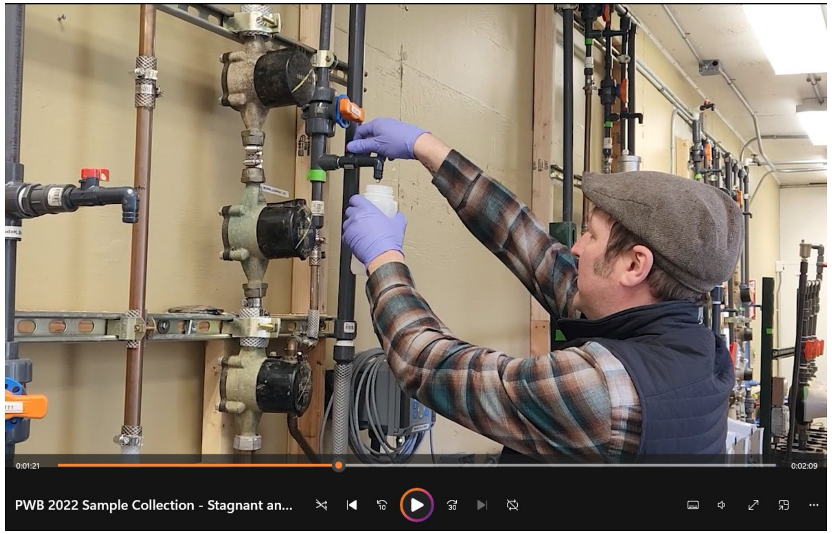
Case Studies (11)	ASDWA Survey Results
Factsheets	Checklists
Design Diagrams	R Code
Interactive Budgeting Tool and Instructions	Videos

YouTube Videos - Nine Utilities

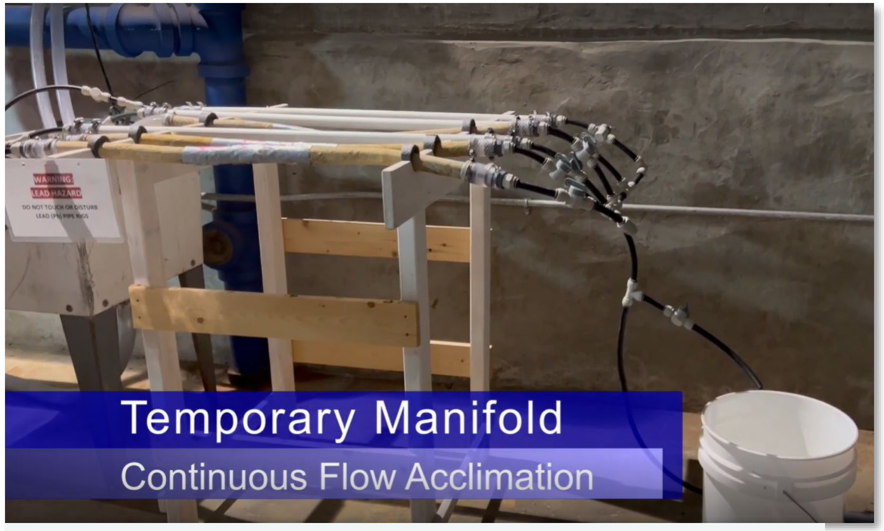
- Overview of various rigs
  - Two pipe rigs – one treatment plant and one sentinel site
  - Recirculating rig
  - Rig with SCADA integration
- Instructional procedures
  - Pipe harvesting
  - Pipe preservation
  - Pipe rig startup
  - Collection of stagnant and flowing water samples
  - Filtering lead samples for dissolved analysis



Courtesy of City of Rochester



Courtesy of Portland Water Bureau



Courtesy of Greater Cincinnati Water Works

Drivers for Conducting Pipe Rig Studies and Associated Impacts

Drivers

Objectives	• Identify study drivers (why are you doing the study) • Summarize influencing factors (supply chemistry and hydraulics, system type, system size, materials present in system)

Informs	• Siting • Design • Operations • Costs • Data analysis requirements

Drivers – Why You Are Doing A Pipe Rig Study

Driver	Important Considerations
Regulatory Trigger	• Pipe Rig Study required under LCRR if a system has lead service lines and lead results exceed action level (including those small systems that opt to do CCT) • If exceed trigger level, state has discretion to require
New Source	• State Discretion if required – may be required if significant changes to the supply portfolio or water quality characteristics. • Voluntary study to understand potential impacts may be appropriate.
Treatment Change	• State Discretion if required – may be required if treatment changes impact WQPs or other characteristics that affect corrosivity of water. • Voluntary study to understand potential impacts may be appropriate.
Voluntary Reassessment of Existing CCT	• Identify opportunities to further reduce lead levels • If exceed trigger level and must re-optimize but state does not require a pipe rig study

Pipe Rig Study Influencing Factors

- **Supply Chemistry**
  - Source and Treatment Compatibility
  - Water Quality Characteristics
  - Existing CCT
- **Supply Hydraulics**
  - Number of Sources
  - Source Usage Patterns
  - Supply Contribution
  - Supply Impact Zones and Blending
- **System Type**
  - Community/ Noncom-munity
  - Regional/ Wholesale Provider
  - Consecutive System
  - Satellite System
  - Consolidated System
- **System Size**
  - Population
  - Available Resources
  - Technical and Financial Capacity
  - Available Facilities
  - Staff Knowledge and Availability
- **Materials**
  - Service Line Inventory
  - Age of Plumbing
  - Other Lead-bearing Materials

The influencing factors have the greatest impact on the design, operation, duration, and cost of a pipe rig study.

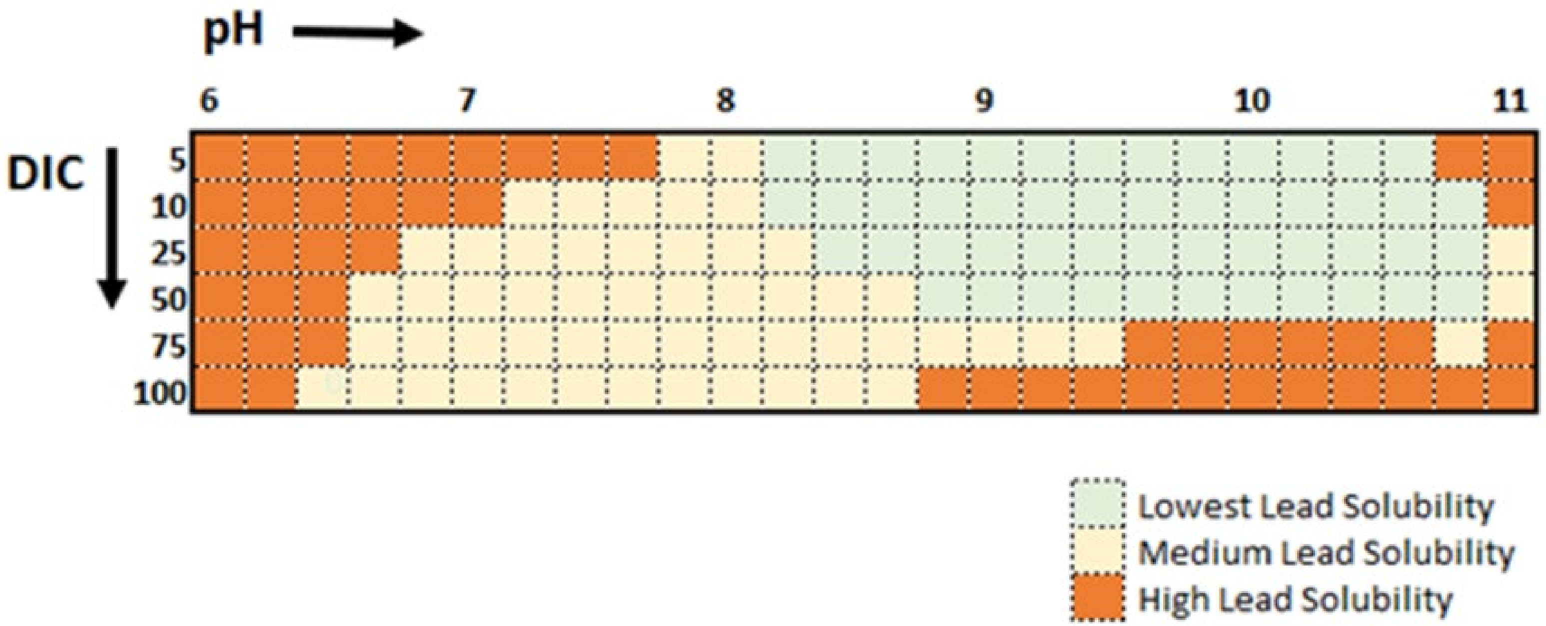
Chapter discusses important considerations and how studies can be geared toward the specifics of the system

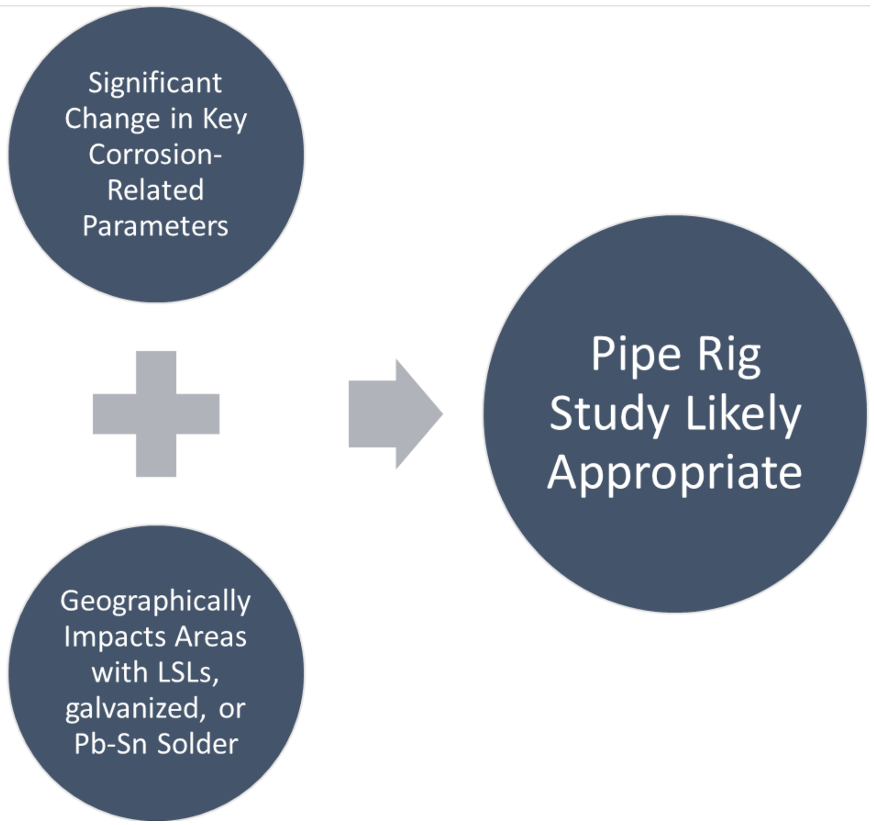
Summary of WQPs and Impacts on Corrosion Performance

Water Quality Parameter

pH	DIC	O-PO_4	ORP	CSMR	Cl_2	Ca
Solubility	Solubility	Solubility	Solubility	Solubility	Impacts ORP	Precipitation potential
Scale type/ stability	Scale type/ stability	Scale type/ stability	Scale type/ stability	Galvanic corrosion	Microbial and biofilm control	Impacts source compatibility
Buffer capacity	Buffer capacity	Competing ions (Al, Ca)				

Impacts of pH and DIC Changes on Lead Solubility





- Sources in orange zones likely require *corrosion control treatment.*
- Introducing a new source or treatment that causes a shift from green to yellow zone warrants a *corrosion control study*.

Summary of Treatment Change Impacts on Corrosion-Related WQPs

Adapted from WRF 5032 and AWWA M58

Note: use of anion exchange for PFAS, arsenic, hexavalent chromium, etc. could simultaneously add chloride and remove sulfate, significantly increasing CSMR

Treatment Change	Change in finished water pH	Change in finished water DIC/Alkalinity	Change in orthophosphate residual	Change in $Cl:SO_4$	Change in ORP	Change in NOM	Change in Biofilm	Change in Temperature	Change in Al/Fe/Mn	Change in stability/ solubility	Change in ORP/ oxidation state
Change in free chlorine dose	•				•		•			•	•
Change from chlorine gas to hypochlorite	•			•						•	
Addition of other oxidants/disinfectants				•	•	•	•		•		•
Conversion to chloramine	•				•		•			•	•
Enhanced coagulation for NOM removal	•	•		•	•	•	•		•	•	•
Change coagulant type or dose	•			•		•			•	•	
Addition of membranes (RO/NF)	•	•		•	•	•	•		•	•	•
Addition of membrane softening	•	•		•	•	•	•		•	•	•
Addition of anion exchange	•	•		•		•				•	
Addition of cation exchange (such as IX softening)	•								•	•	
Change in finished water pH	•						•			•	
Change in finished water alkalinity	•	•								•	
Addition of a corrosion inhibitor	•	•					•			•	
Change in corrosion inhibitor product or dose (such as change in poly/blended/orthophosphate)	•		•						•	•	
Addition of lime softening	•	•									

Fact-Sheets

Impact on Solubility	Impact on Scale Type	Example Danger, Warning, and Safe Zones

pH

Predicted lead solubility depends on DIC (see solubility curve) except at approximately pH 8. At lower pH levels, lead solubility decreases with increasing DIC and pH. At higher pH, lead solubility decreases with pH under low DIC conditions until about pH 10 and then increases with both pH and DIC under moderate to high DIC conditions.

As pH increases, hydrocerussite becomes the controlling lead scale. The scale transition occurs at different pH depending on the DIC (and the modelling assumptions). In the presence of orthophosphate, pH, DIC, and orthophosphate level will impact the scale type and transition zones.

- A change of 0.5 pH units can significantly increase solubility when DIC < 10 and disrupt the chemical equilibrium in the pipes, especially at pH ≤ 8.0.

- Lead solubility theoretically independent of DIC around pH 8.0. But significant DIC changes (e.g., from 5 to >> 25) can impact controlling solid.

- If DIC ≥ 25 mg/L, insignificant changes in lead solubility between pH 7.2-8.2.

Prepared for:
pH,
Orthophosphate,
Temperature,
DIC,
Alkalinity

Case Studies

Water System	Type of Previous / Ongoing Pipe Test	Existing CCT	Study Drivers	Influencing Factors
Mass. Water Resources Authority (MWRA)	Acclimating harvested pipe in pipe loops, but considering next steps	pH and alkalinity adjustment	Voluntary reassessment to optimize lead control, also past lead ALEs at individual wholesale customers	Quantity and variety of wholesale customers
NYCDEP	Two harvested pipe loops in two locations evaluating different sources	Ortho	Voluntary reassessment to optimize lead control (in preparation for LCRR)	Orthophosphate boosting and partial system study option, supply blending
City of Rochester Water Bureau	Pipe loop study began in 2021	pH adjustment	Voluntary reassessment to optimize lead control, but driven by potential for future ALE	Secondary supply is purchased water (Chemistry compatibility)
Great Lakes Water Authority (GLWA)	Constructed 40 flow-through pipe rigs at 10 locations with harvested and new materials	Ortho	Voluntary reassessment driven by lowered State AL and potential for future ALE by the receiving systems	Wholesale customers, five water treatment plants that blend in the distribution system
Greater Cincinnati Water Works (GCCW)	Constructing a flow-through pipe loop	pH adjustment	Voluntary reassessment to optimize lead control, but driven by potential for future ALE	Evaluate impacts of transitioning from pH adjustment to ortho
Portland Water Bureau (PWB)	Flow-through system using harvested and manufactured copper with lead solder	pH adjustment	Lead ALE	Wholesale customers with and without other supplies, No LSLs

Case Studies (con't)

Water System	Type of Previous / Ongoing Pipe Test	Existing CCT	Study Drivers	Influencing Factors
Tacoma Water	Harvested pipe rigs at three locations, evaluating alternating between GW and SW	pH adjustment	Voluntary re-assessment to optimize for lead and supply compatibility	Surface water and groundwater sources, significant treatment changes, no LSLs, some lead goosenecks
Aqua Water Utility Services	Flow-through pipe rig study for a medium system	Polyphosphate for sequestration	Optimizing for lead and copper, blending of sources, source and treatment changes	Changing from a groundwater with sequestration to a surface water with softening and conventional filtration
EPCOR	Loops with all new materials for CCT evaluation	pH adjustment	Voluntary re-assessment following the reduction of lead MAC	Seasonal changes in source water quality and operational practices at the water treatment plant
Halifax Water	Lead coupons and pipe rigs with harvested and new materials	Zinc ortho and pH adjustment	Voluntary re-assessment	Studies have evolved over the years, but the main driver has been optimizing orthophosphate)
City of Toronto	Harvested lead service lines, operational since 2011	Ortho	Confirm effectiveness and optimize CCT for lead	Sentinel loops in the distribution system

Summary

- Water systems may need to conduct pipe rig studies under the LCRR
  - Regulatory Trigger
  - Source Change
  - Treatment Change
  - Voluntary re-optimization
- Clearly defining study drivers is critical to study success (and approval)
- A clear understanding of influencing factors is needed for proper siting, design, and operations to meet study objectives

WRF 5081 Driver chapter and associated guidance will help systems and States understand when and why pipe rig studies are appropriate, and important design and operational considerations to meet system-specific conditions

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Thank You!

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