

## ANALYSIS OF DISTRIBUTION SYSTEM AND DOMESTIC SERVICE LINE PIPE DEPOSITS TO UNDERSTAND WATER TREATMENT/METAL RELEASE RELATIONSHIPS



### IMPACT STATEMENT

Understanding the water treatment systems and the chemistry of metal release from plumbing will help to solve corrosion control, improve water treatment and resolve regulatory compliance problems for specific utilities in the U.S. Environmental Protection Agency's (EPA) technical support role. This project will work to improve the basis for water chemistry modeling to better predict metal release, corrosion behavior, and treatment change impacts so that replaced water infrastructure will not have the same life-cycle problems as existing systems. EPA will be able to better educate utilities, consultants, and regulators, which will prevent treatment mistakes due to overlooked problems with the new water systems.

### BACKGROUND:

In 1989, this project was started in an effort to corroborate the results of efforts to predict the corrosivity of drinking waters to large distribution system infrastructure materials and premise plumbing. Early results revealed significant surprises in the composition of protective pipe scales, which often differed from assumptions that had been made about operable corrosion control and scaling mechanisms. Notable examples include the importance of tetravalent lead deposits in mitigating plumbosolvency in many water systems; the critical role of iron, manganese, and aluminum solids in scavenging trace metals and radionuclides; and affecting corrosion and release of lead and copper were revealed. The program is also involved with following the physical and mineralogical evolution of pipe deposits in response to corrosion control or other treatment changes, to develop or corroborate corrosion and corrosion control theories.

### DESCRIPTION:

The Office of Research and Development's National Risk Management Research Laboratory has funded this research project in support of its Aging Water Infrastructure (AWI) Research Program. Samples tested for this research include pipe samples, scales from storage tanks, failed plumbing devices and distribution system sediments. These samples are obtained through technical support efforts by water systems, consultants, state regulators, and EPA regional offices. Solids analysis performed on these samples are primarily done in-house by on-site contractors. Tests performed by the on-site contractors include optical mineralogy; photomicroscopy; sample preparation; scanning electron microscopy/energy dispersive x-ray spectrometer/wavelength dispersive x-ray spectrometer (under development); X-ray diffraction (XRD); X-ray fluorescence (under development); total carbon (TC); total sulfur (TS); and total inorganic carbon (TIC). Tests performed through an interagency agreement with the U.S. Geological Survey include digestion and elemental analysis for 40+ metal and rare-earth elements; capability for mercury; capability for LA-ICP-AES/MS; and backup tests for TC, TS, and TIC.

Chemical speciation of scale materials and corroboration of some XRD results is also determined for some projects using synchrotron methods such as X-ray Absorption Near-Edge Spectroscopy and X-ray Absorption Fine Structure

spectroscopy using the facilities at the Argonne National Laboratory Advanced Photon Source. The results of these analyses are used to deduce operable corrosion, corrosion inhibition, metal accumulation and metal release mechanisms occurring in different water systems, or to predict the impact of various proposed changes in disinfection or other treatments on the stability of existing pipe scales and deposits.

This project puts EPA into a unique position of being able to bring analytical tools to bear to solve or anticipate future drinking water infrastructure quality and metallic or cement material performance problems for which little application expertise for drinking water systems exists in either universities or the private sector.

EPA GOAL: Goal #2 - *Clean & Safe Water*; Objective 2.1.1- *Water Safe to Drink*

ORD MULTI YEAR PLAN: Drinking Water (DW), Long Term Goal - *DW-2 Control, Manage, and Mitigate Health Risks*

#### RESEARCH PARTNERS:

*Collaboration:* Municipal water systems, consulting firms, state drinking water programs, and EPA Regional Offices

*Contractors:* Pegasus Technical Services; Battelle (Columbus)

*Supporting Agencies:* U. S. Geological Survey (Interagency Agreement); U. S. Department of Energy (facilities accessed at the Advanced Photon Source, Argonne National Laboratory)

### EXPECTED OUTCOMES AND IMPACTS:

This research project is expected to improve water chemistry modeling to predict metal release due to various operational changes. This improvement will aid in decision-making for the operation, maintenance, and replacement costs of the nation's aging water infrastructure; extend the service life and functionality of existing conveyance systems; and reduce life cycle costs. This project will also show the extent of corrosion in our water infrastructure and existing corrosion control mechanisms operating in different water distribution systems, which have prevented major lead release episodes. These effective corrosion control mechanisms have also been vital in accomplishing disinfection and other treatment changes in the infrastructure. Some systems, which have been thought to be effective in lower lead through carbonate passivation, are actually reducing it through the formation of lead dioxide. This limits future disinfection options.

### OUTPUTS:

Current and future outputs of the project will consist of journal articles; conference presentations; contributions to revisions of regulations and guidance by EPA; data reports to clients; and solutions of real-world utility infrastructure-related water quality, corrosion, and transmission problems.

### RESOURCES:

Aging Water Infrastructure Research Program: <http://www.epa.gov/awi/>

Corrosion, Scaling, and Metal Mobility Research: <http://www.epa.gov/nrmrl/wswrd/cr/index.html>

Lytle, D. A. and Schock, M. R. *Pitting of Copper in High pH and Low Alkalinity Waters*, Journal of the AWWA 100 (3), 2008:115-128. <http://www.awwa.org/>

Schock, M. R., Hyland, R. N. and Welch, M. M. *Occurrence of Contaminant Accumulation in Lead Pipe Scales from Domestic Drinking-Water Distribution Systems*, Environmental Science & Technology, 42 (12), 2008:4285-4291.: <http://pubs.acs.org/>

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Drinking Water



Aging Water Infrastructure