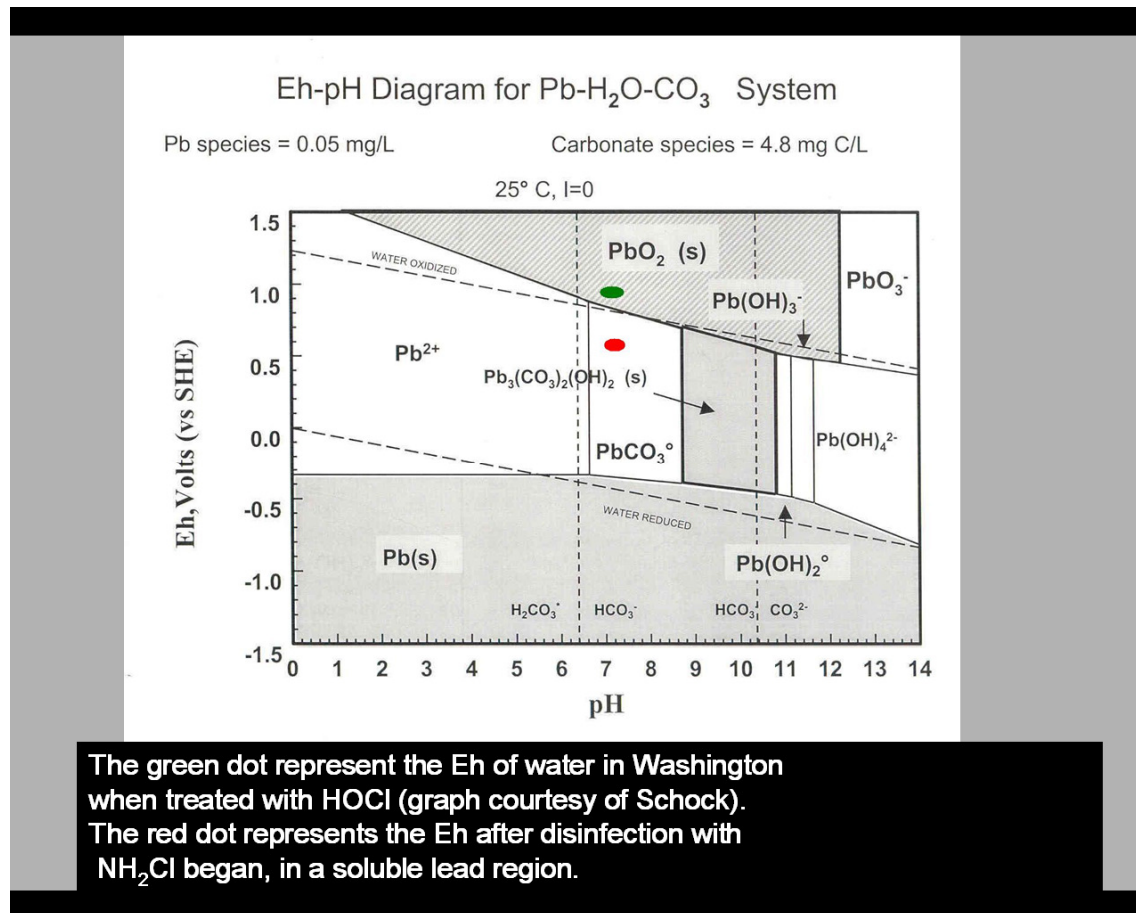


What events have led to the Pb problem in drinking water in DC since 2001?

There are two competing water quality regulations that helped bring about the lead crisis: 1) the 1998 Disinfection Byproduct Rule (DBR) which requires that byproducts of disinfection (such as the trihalomethane formed when chlorine disinfectant reacts with humic acid) stay below a Maximum Contaminant Level (MCL), and 2) the 1991 Lead and Copper Rule (LCR) which sets an “action level” of 15 ppb. In an effort to further comply with the more stringent DBR, Washington D.C.’s wastewater treatment companies decided to switch from chlorine to chloramine disinfection, which raised the pH and lowered the water’s oxidizing potential, inadvertently causing an increase in the amount of soluble lead in drinking waters (1). See graph (2).



To remove the lead (make it insoluble, as in the grey regions of the graph above), the pH would have to be increased by adding a base, or the oxidative potential would have to be increased.

Where could the lead be coming from?

A. PbO₂ scales reducing under the lower ORP promoted by chloramine use.

Schock’s study in Cincinnati water pipes revealed thin, uniform scales or a film of PbO₂ that was stable and “tenacious,” and he concluded that these scales had formed in high ORP conditions (as promoted by chlorination), effectively removing much of the soluble lead from the water (2). A switch to a lower ORP condition (as promoted by chloramine disinfection), would convert this insoluble PbO₂ to soluble lead (II) ion.

B. Leaching/ Corrosion of plumbing containing lead under the lower ORP promoted by chloramine use.

Renner noted that “lead-free” brass can still contain up to 8% lead and that it is also found in the solder used to weld pipes together (1). Edward’s studies of chlorinated and chloraminated water’s effect on brass indicated an increase in lead leaching by a factor of ~2 (pH range 7.2-8.5) with the use of chloramine, with five time increase in lead at pH 8.5 (3).

In brass galvanized with copper, the electrochemistry switches in the presence of chloramine presence and the brass becomes anodic (sacrificed) and copper cathodic (protected) (1). Renner notes that “galvanic corrosion current persists for days, even without a new supply of water....’[quoting Edwards] the entire copper plumbing network in the house can act to accerlerate the corrosion of the brass right at the faucet where the water is collected. Lead leaching can increase 4 to 100 times faster than normal.’ (1)”

Why does adding PO_4^{3-} (to increase the pH) not completely solve the problem?

For phosphate to increase the pH and have an effect on the lead leaching and reduction of insoluble lead compounds, it would have to be released into the drinking water supply. Unfortunately, Edwards noted that lab tests indicated that phosphate dosing may tend to cause a detachment and dispersal of lead particulates that would adhere to surfaces in the absence of the phosphate (3). Thus, while PO_4^{3-} would induce insoluble forms of lead, it would also perhaps interfere with these insoluble precipitates’ ability to form stable scales or aggregate solids that could be easily filtered or removed. These finely dispersed particulates would then make their way through the tap.

Furthermore, lab tests showed that the pH of water exposed to iron and lead had an overall decrease in pH with increased stagnation time (4), further complicating the relationship of pH, ORP, solubility, and galvanic corrosion.

Since PO_4^{3-} is a nutrient that contributes significantly to natural water eutrophication, the PO_4^{3-} waste must be removed post-consumer if the water is to be discharged into the environment rather than recycled.

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