

# **Destabilization of Lead Pipe Scales in a Long-Term Vacant Home in Cincinnati**

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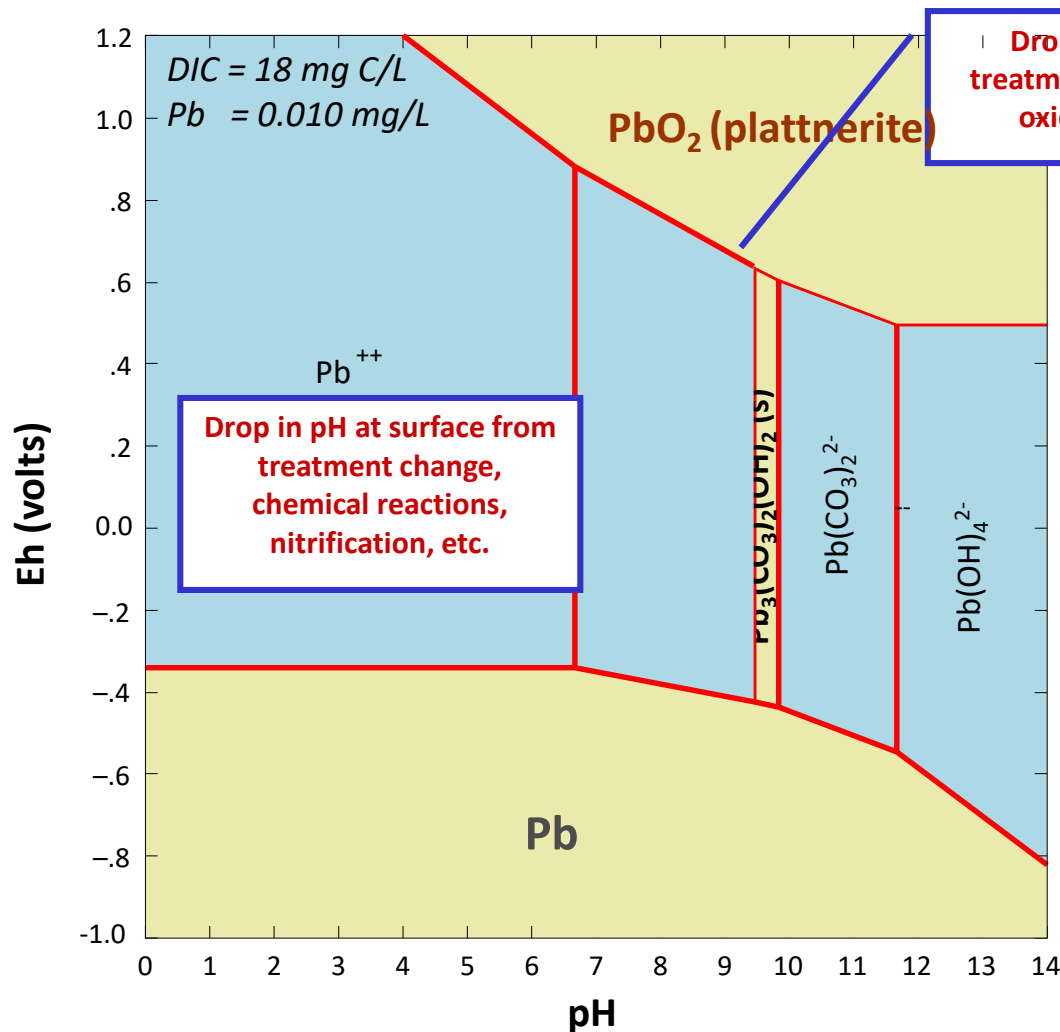
07/17/2014

Hamilton County Lead and Healthy  
Homes Collaborative – 01/18/2018

# *IMPORTANCE OF $PbO_2$ SCALES*

- Found in approximately 1/3 of 53 water systems whose pipes have been examined by USEPA
- Major mineral phase in small number of tested systems
- Several research groups have shown it forms from Pb(II) carbonate and hydroxycarbonate when oxidation/reduction potential (ORP) is sufficiently high and persistent
- Laboratory and field investigations suggest very low solubility

# WAYS TO DESTABILIZE $PbO_2$



Can be reduced back to Pb(II) phases if ORP is not maintained

- chlorine to chloramine
- loss of chlorine residual
  - Reaction with bulk water reductants
  - Reaction with DS and premise plumbing materials

# *Cincinnati LSL scales*

- Stable long-term (many years) water treatment and chemistry with respect to critical water parameters
- 17 LSL samples extracted between early 1990's and 2014
  - 15 show nearly complete scale coverage by  $\text{PbO}_2$
  - 2 show hydrocerussite and other  $\text{Pb(II)}$  phases developed at the scale/water interface, with  $\text{PbO}_2$  underneath.



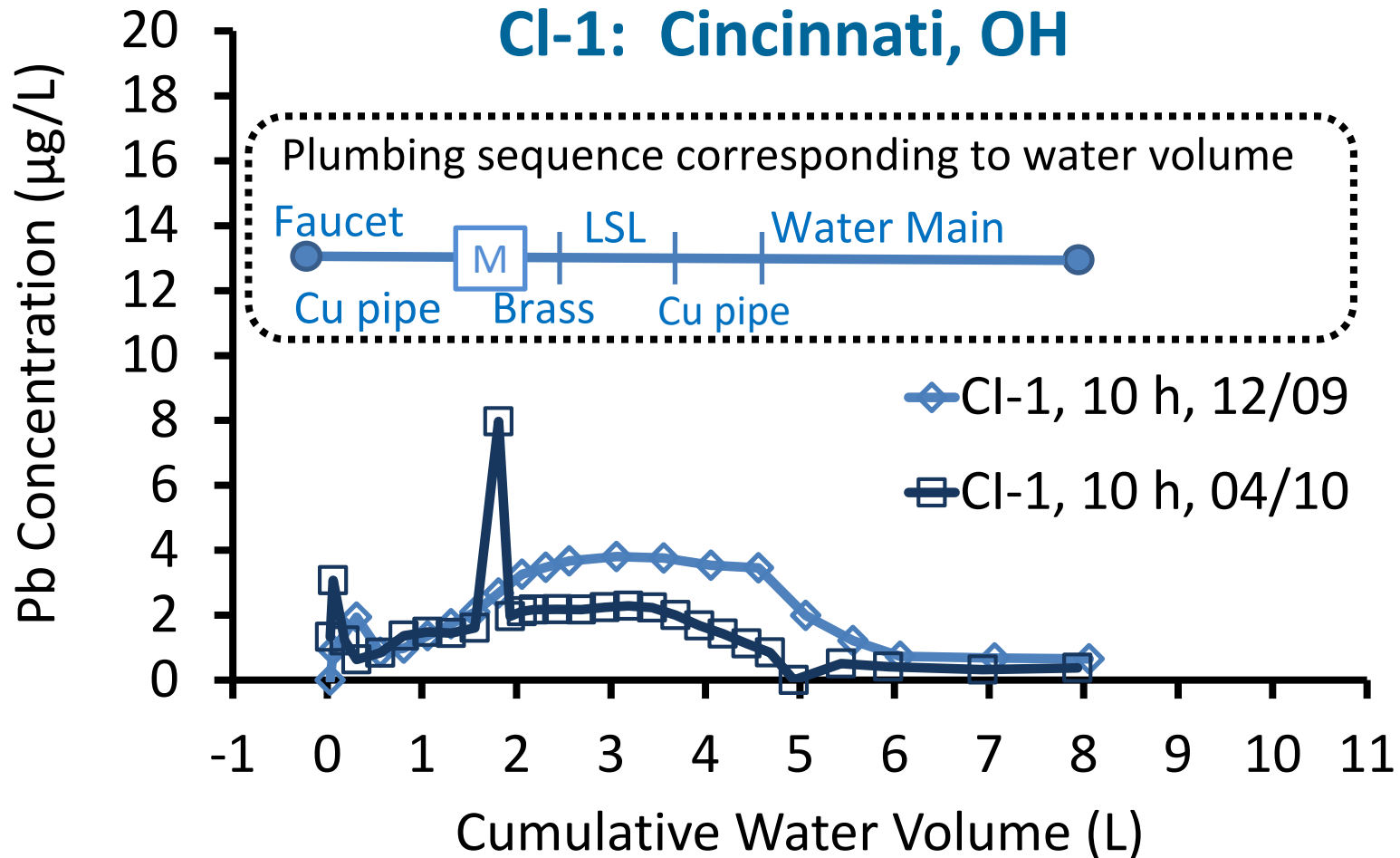
# CINCINNATI WATER QUALITY

Major Parameters <i>Average (range)</i>	
pH	8.6 (8.3 - 8.9)
Alkalinity (mg/L as CaCO <sub>3</sub> )	74 (44 - 109)
TIC (mg/L as C)	17 (10-26)
Disinfectant Type	Free Chlorine
Free Cl <sub>2</sub> Residual (mg/L)	1.26 (0.94-1.62)
Sodium hexametaphosphate (mg/L as P)	0.23 (0.18-0.30)
Ca <sup>2+</sup> (mg/L)	36 (31 - 40)
Mg <sup>2+</sup> (mg/L)	8 (4 - 11)
Na <sup>+</sup> (mg/L)	26 (13 - 51)
K <sup>+</sup> (mg/L)	--

Anions & Minor Constituents <i>Average (range)</i>	
Al <sup>3+</sup> (mg/L)	0.08 (0.0-0.3)
SiO <sub>2</sub> (mg/L)	0.18 (--)
Fe <sub>T</sub> (mg/L)	--
Mn <sub>T</sub> (mg/L)	0.01 (0.00-0.01)
Cl <sup>-</sup> (mg/L)	27 (18 - 34)
SO <sub>4</sub> <sup>2-</sup> (mg/L)	70 (46 - 115)
F <sup>-</sup> (mg/L)	0.98 (--)
NO <sub>3</sub> <sup>-</sup> -N (mg/L)	0.8 (0.5 - 1.1)

*R. W. Miller Plant, 2009—2012, courtesy of Greater Cincinnati Water Works (GCWW)*

# DETAILED SEQUENTIAL SAMPLES

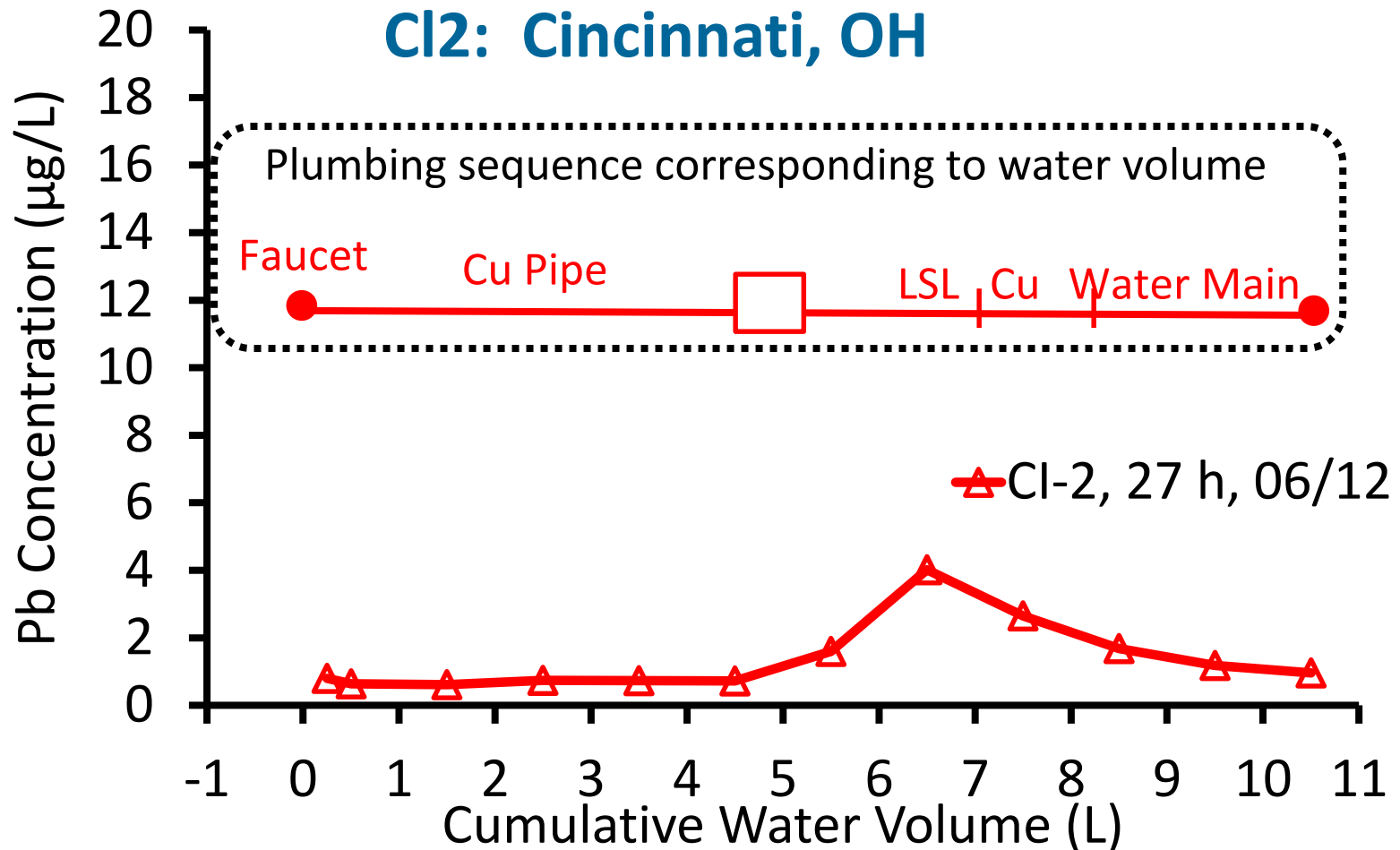


Schock et al. 2014. AWWA ACE.

Triantafyllidou et al. 2015. ES&T. 49:3746-3754

# DETAILED SEQUENTIAL SAMPLES

## CL2: Cincinnati, OH

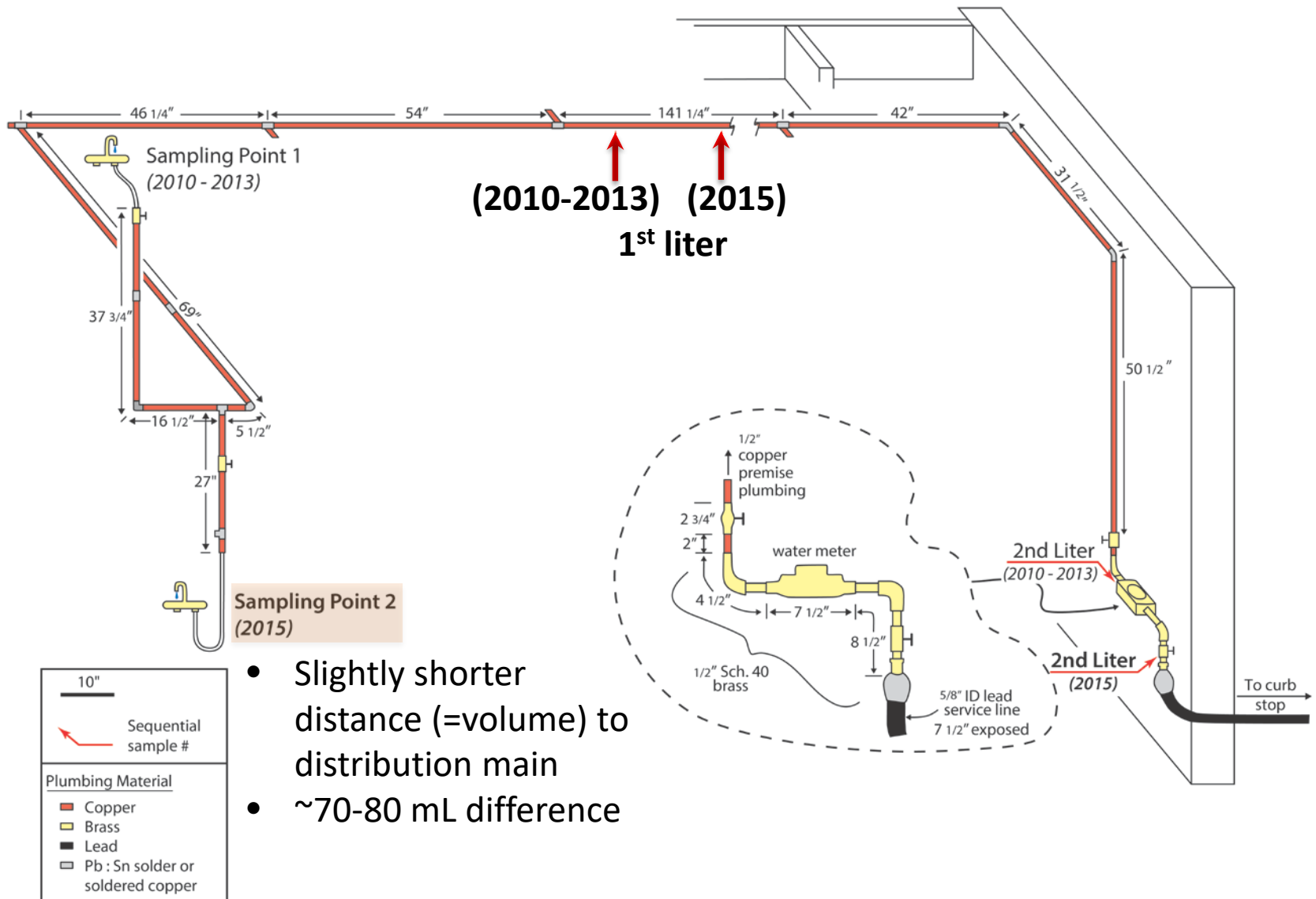


Schock et al. 2014. AWWA ACE.

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# REVISITING SITE CI-1



- Slightly shorter distance (=volume) to distribution main
- ~70-80 mL difference

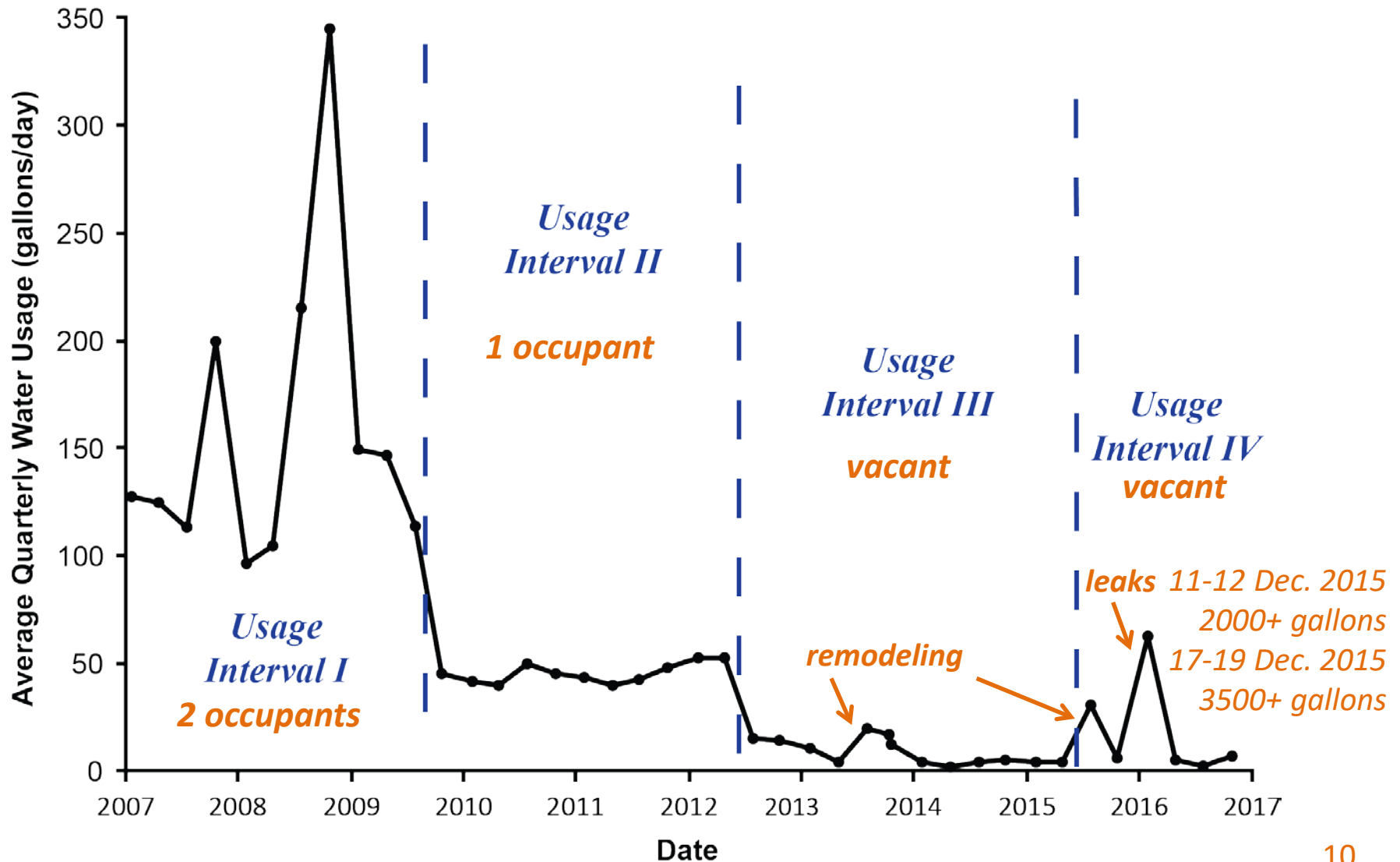


# *WATER SAMPLING*

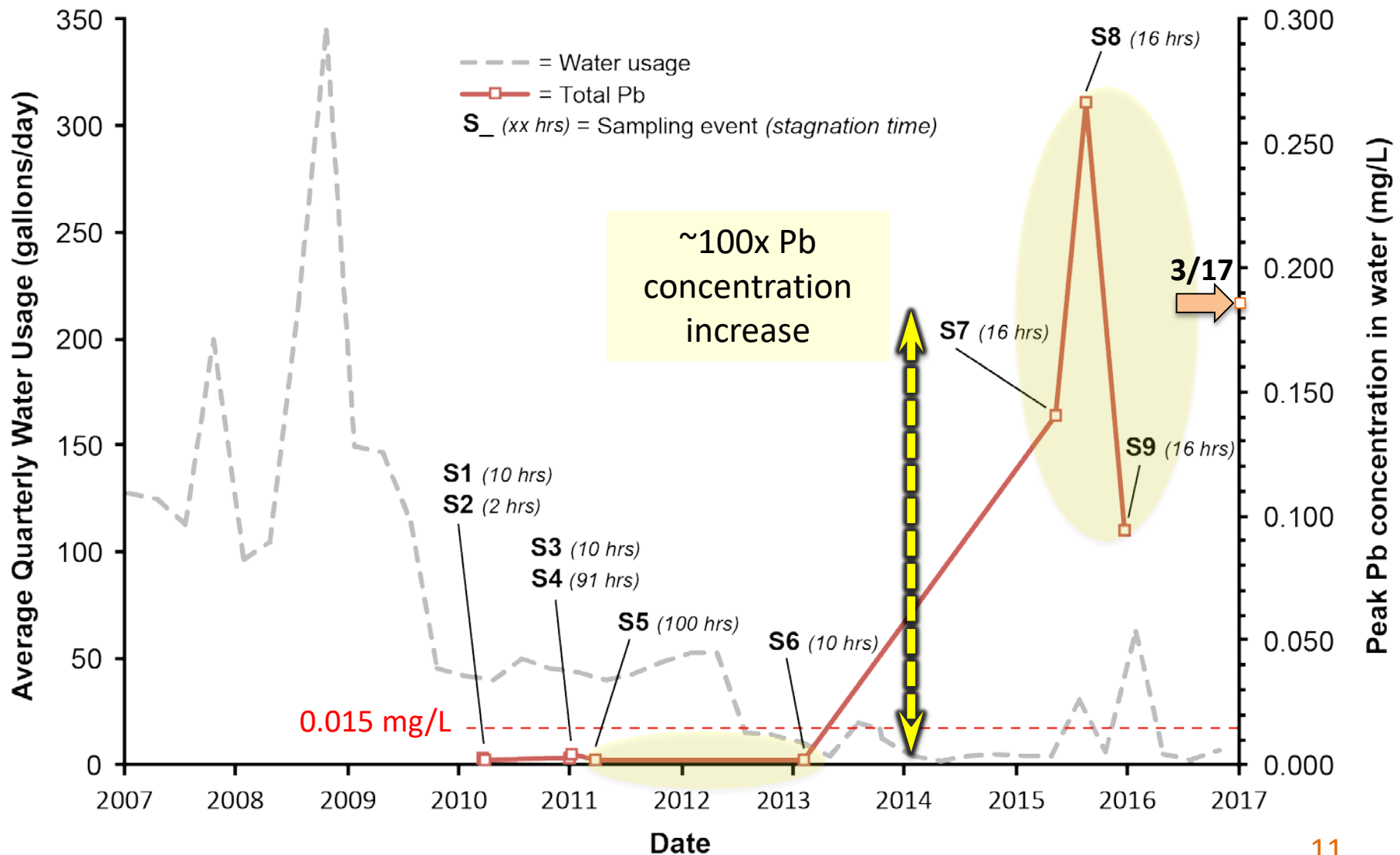
- Pre-flushed for 5 minutes before stagnation period
  - Consistent baseline for comparisons
  - This is not LCR sampling procedure!!!!
- Sampled at flow rate of ~ 5 liters per minute
- Sequential 1-liter samples collected in wide mouth polyethylene bottles
- Additional liter and 40 ml vials collected during some events after flushing the line in order to characterize distribution main water

# SITE CI-1 WATER USE: 2007-2017

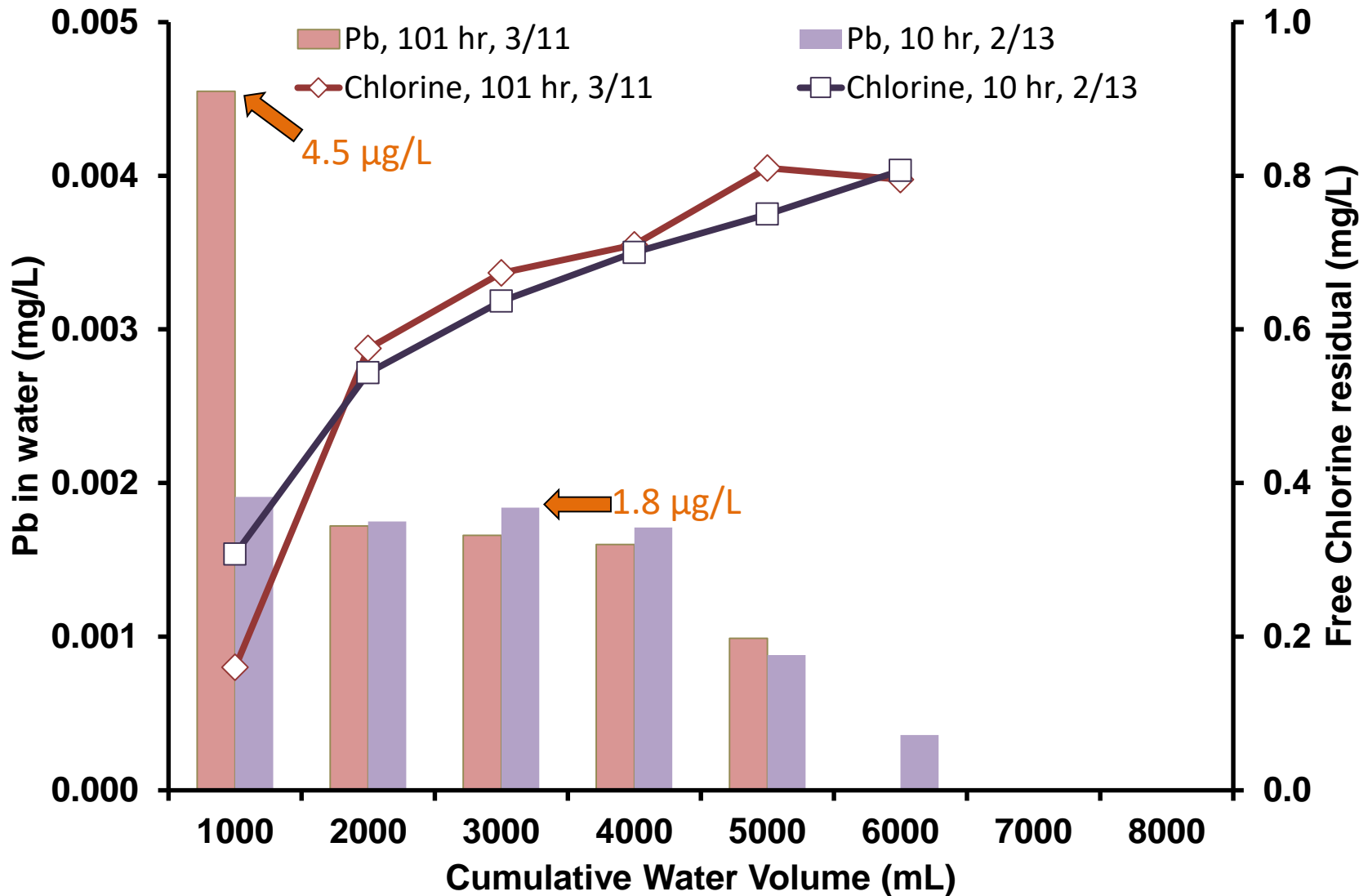
Based on GCWW quarterly billing records



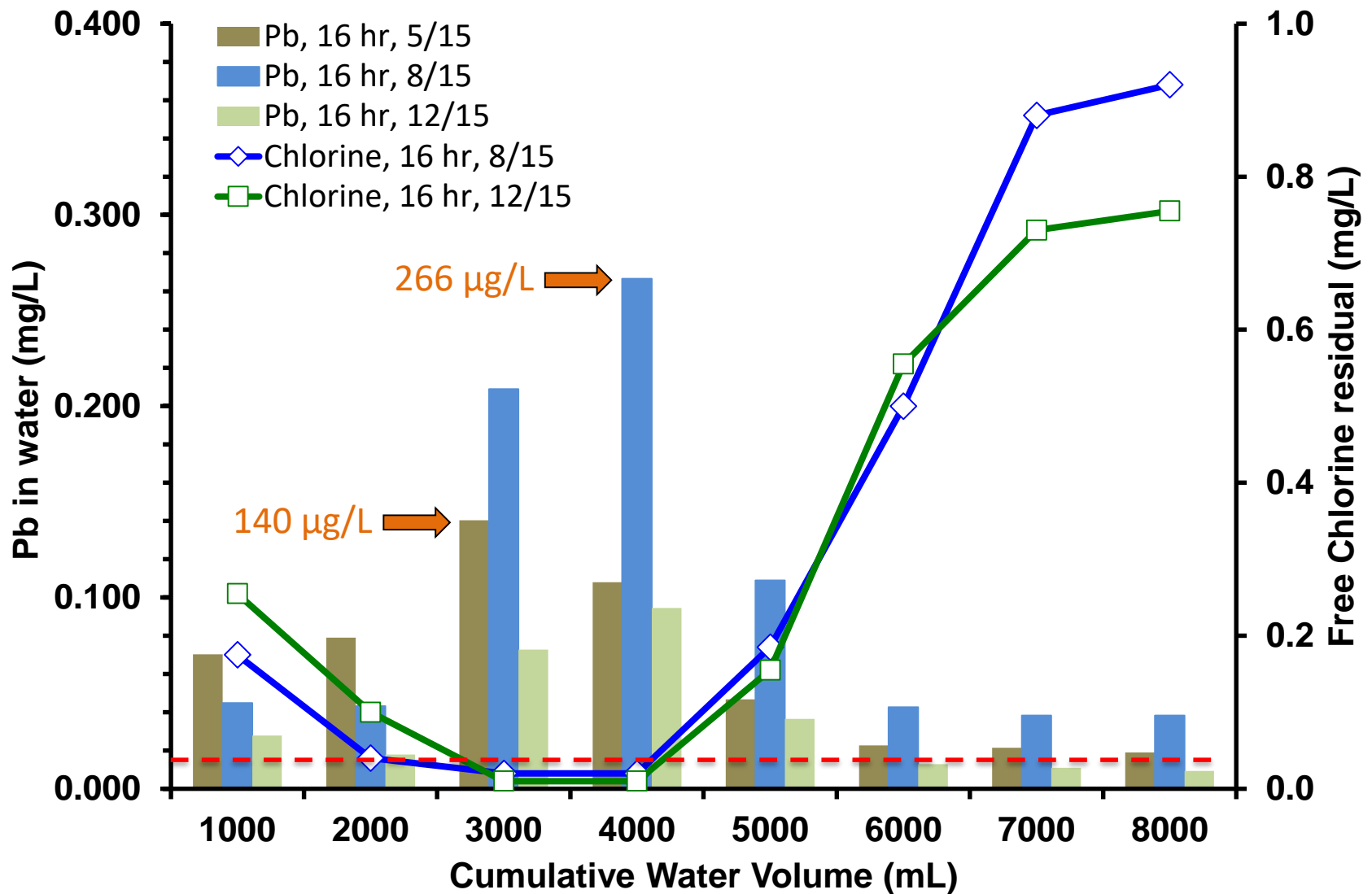
# LEAD LEVELS IN LSL INCREASED



# SEQUENTIAL LITERS 2011-2013

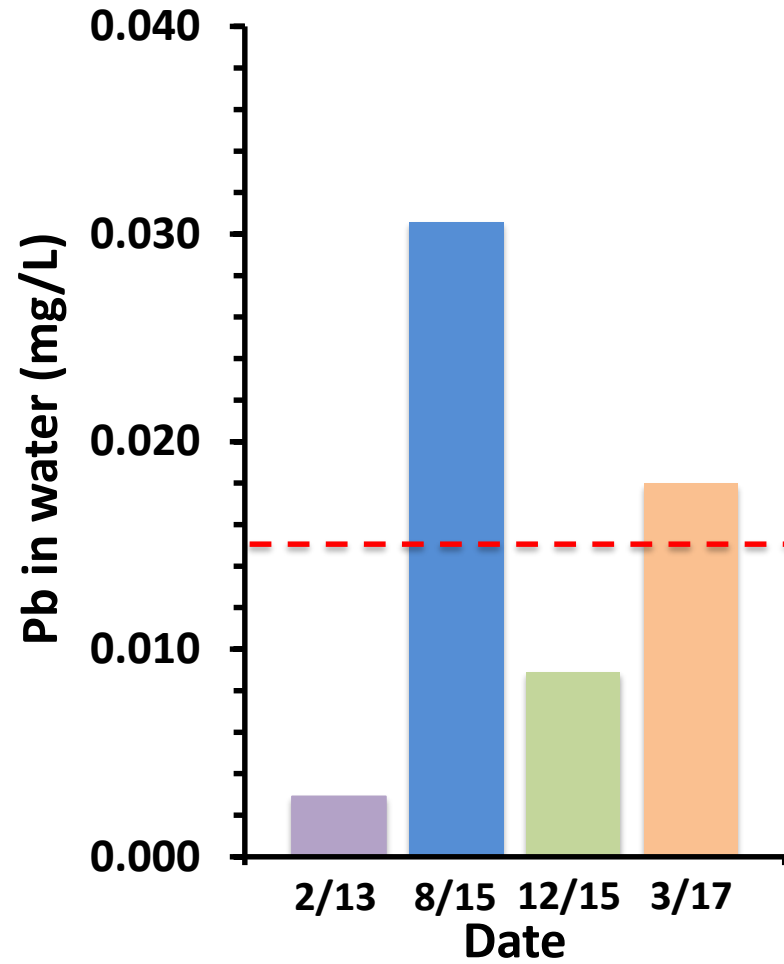


# SEQUENTIAL LITER SAMPLES 2015

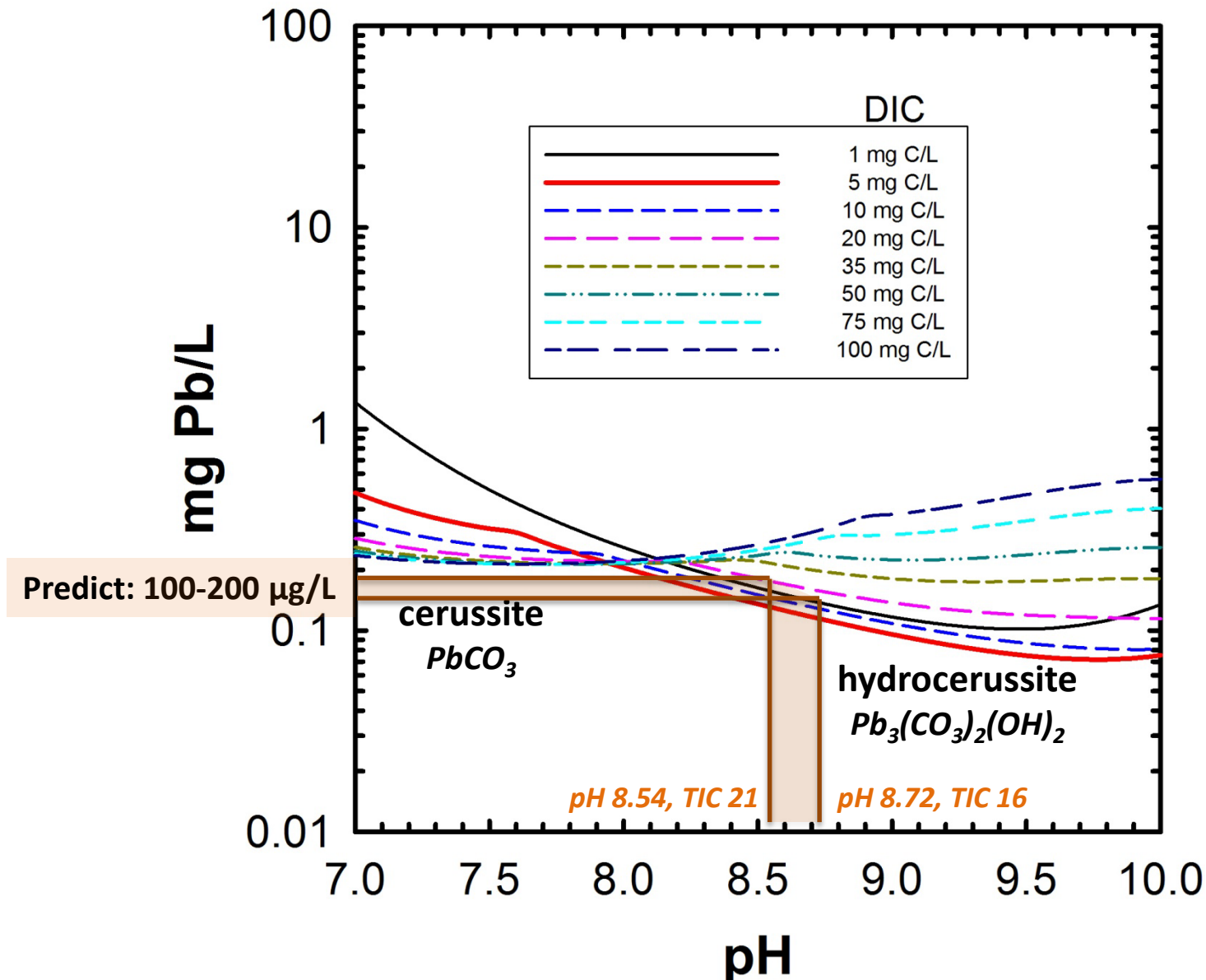


# *LEAD IN 5-MIN FLUSHED SAMPLES*

- No stagnation
- Reflects Pb picked up by water merely passing through pipe.
- 3x to 10x increase from 2013 levels



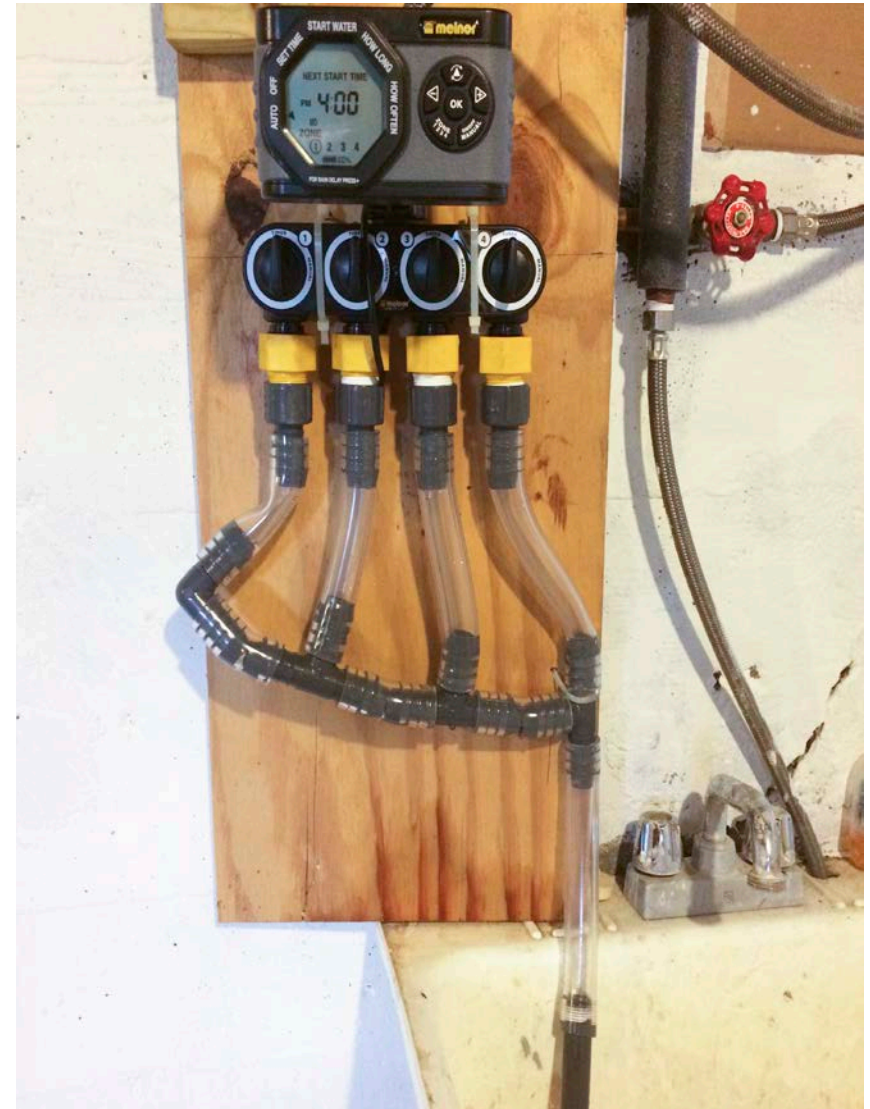
# PHASE PREDICTION FOR Pb LEVELS



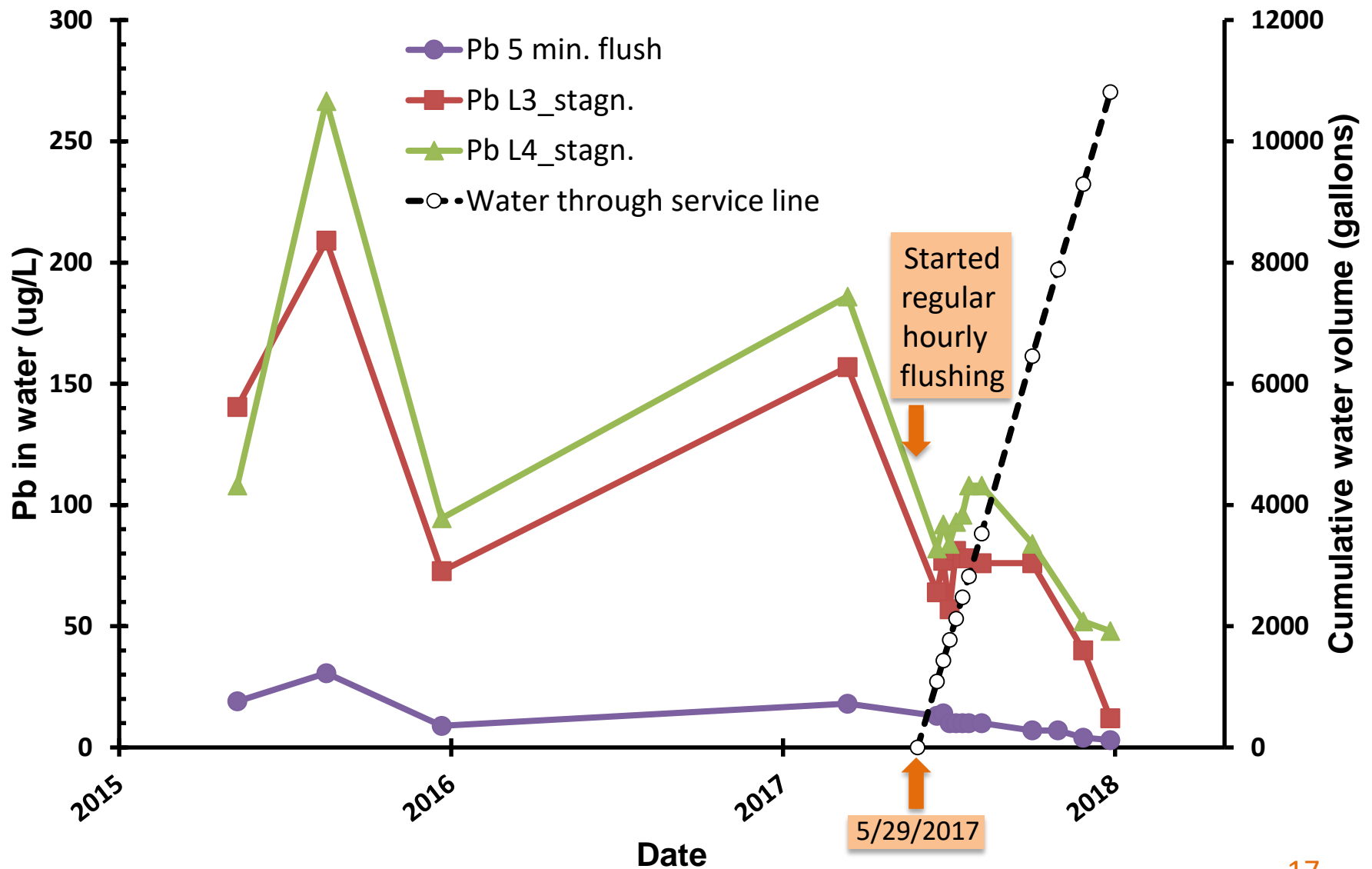


# REHABILITATION

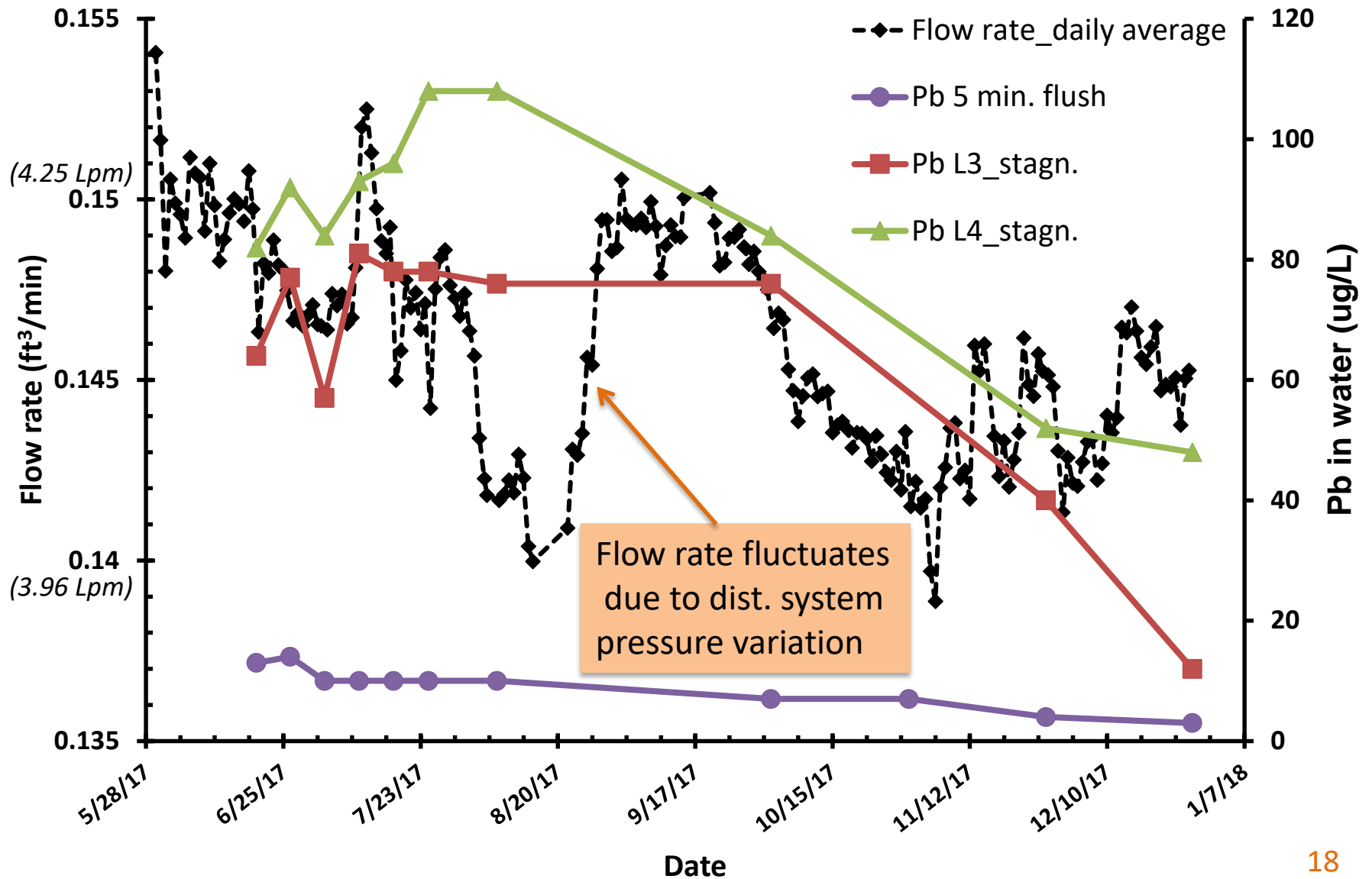
- **Just add water??**
- Irrigation timer connected to premise plumbing near sampling point
  - Flush line for 2 minutes every hour at ~4.25 Lpm
  - ~8.5 liters each flush
  - ~204 liters (54 gallons) per 24 hour period
- Started 5/29/2017
- Periodically evaluate progress by analyzing Pb level and chlorine residual in service line



# PROGRESS



# PROGRESS



# *BIGGER PICTURE*

**What about other vacant houses with  
lead service lines in Cincinnati???**

# VACANT HOMES

- Properties foreclosed and abandoned due to the 2006 housing crisis
- Economic migration with lost industry

However...

- Improving housing market conditions means that some will be reoccupied



# Lead service lines in Cincinnati

- Cincinnati Enquirer (02/25/2016)
  - 236186 active services
  - 18527 active lead services (count only included full LSL)
- Greater Cincinnati Water Works Service Line information map
  - accessible from GCWW Lead Awareness page  
<http://cincinnati-oh.gov/water/lead-information>
  - Can look up individual services by address
  - Information about full, partial, or no LSL

Top 20

Neighborhood /Municipality	Total Active Services	Active Lead Services (Full LSL)	Percent with LSL
Evanston	2430	1288	53.0
Lower Price Hill	515	211	41.0
South			
Cumminsville	494	187	37.9
Camp Washington	624	229	36.7
East Price Hill	3479	1275	36.6
East Walnut Hills	962	348	36.2
Walnut Hills	1781	595	33.4
East End	654	215	32.9
Corryville	899	293	32.6
Mount Auburn	1798	515	28.6
Hyde Park	3890	1069	27.5
Northside	3432	901	26.3
Heights	430	111	25.8
Linwood	582	149	25.6
CUF	2305	589	25.6
Cheviot	3042	769	25.3
West Price Hill	5992	1493	24.9
Pleasant Ridge	2811	698	24.8
Avondale	2874	684	23.8
West End	1411	331	23.5

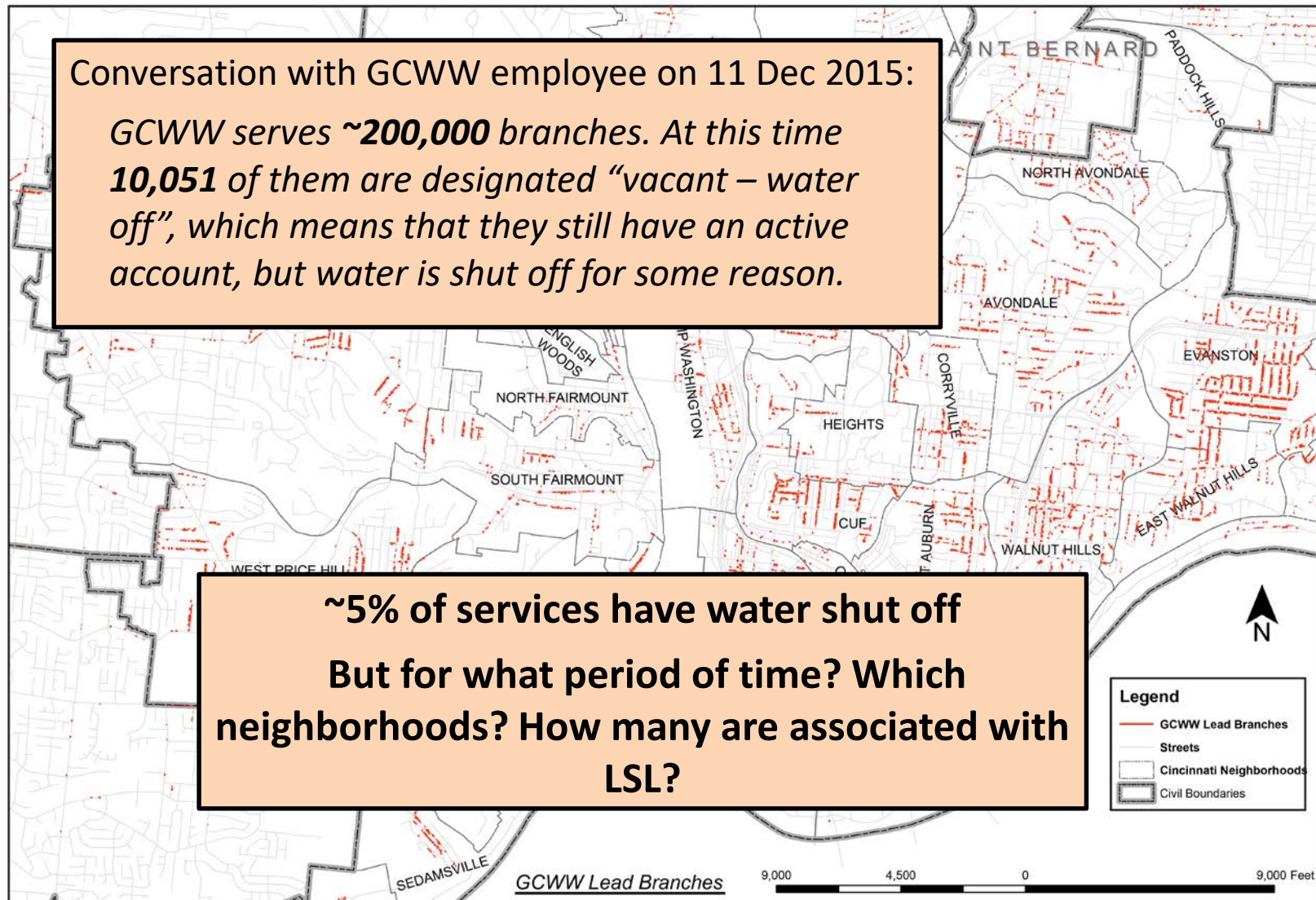


# Lead service lines in Cincinnati

Conversation with GCWW employee on 11 Dec 2015:

*GCWW serves ~200,000 branches. At this time 10,051 of them are designated “vacant – water off”, which means that they still have an active account, but water is shut off for some reason.*

**~5% of services have water shut off  
But for what period of time? Which  
neighborhoods? How many are associated with  
LSL?**





# *Vacant buildings – example sources of information*

- ~~HUD/USPS Vacant Address database (mail receiving locations, aggregated quarterly by census tract)~~

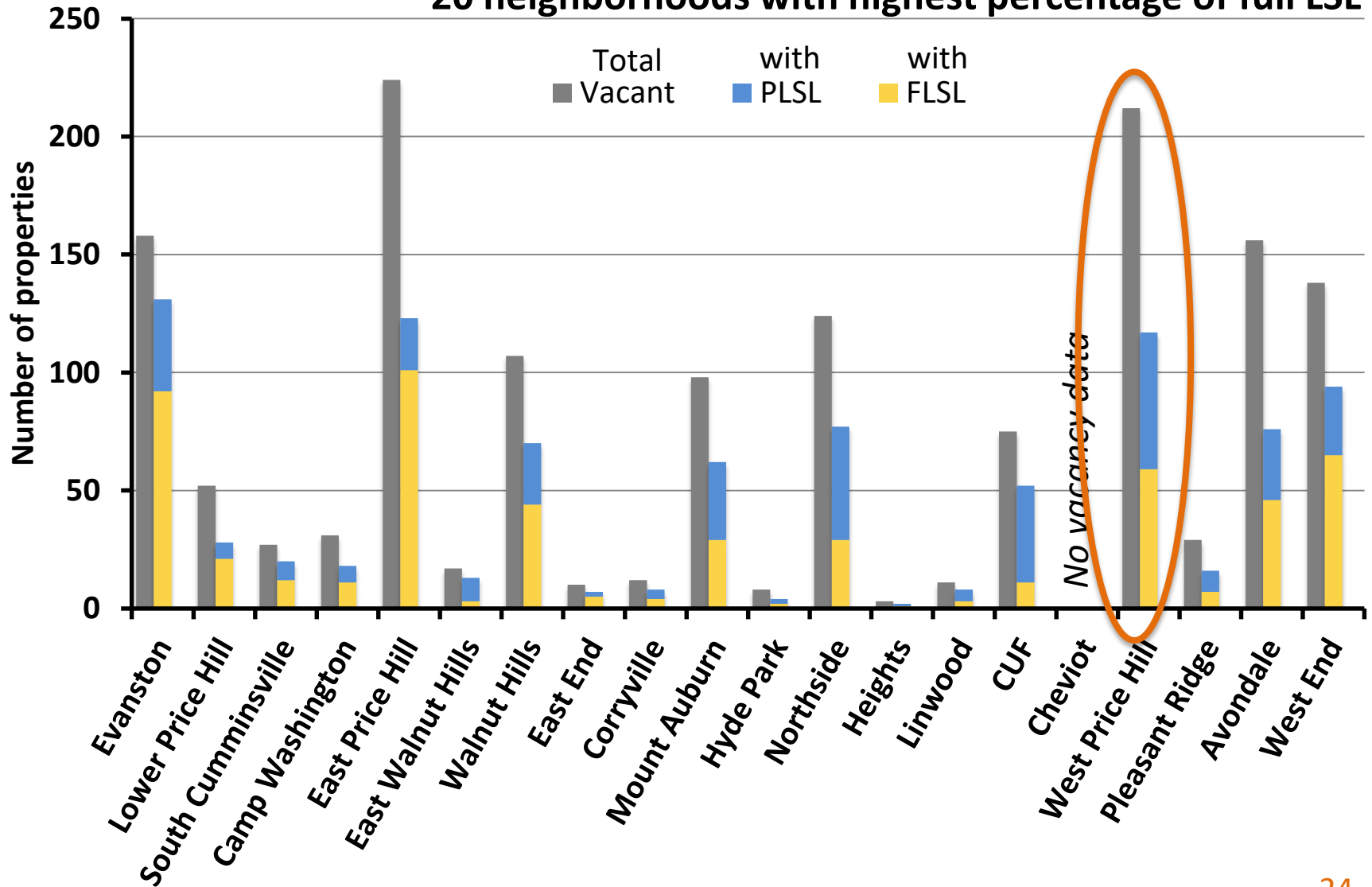
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- City of Cincinnati – Vacant Foreclosed Property Registration  
<http://cagismaps.hamilton-co.org/cincinnatiServices/VacantForeclosedRegistration>
- Vacant Buildings in Cincinnati  
<http://cagismaps.hamilton-co.org/cincinnatiServices/CodeEnforcement/CincinnatiVacantBuildingCases/>
- Hamilton County Auditor/CAGIS (specific property lookup)  
<http://cagisonline.hamilton-co.org.cagisonline/index.html>

Listings by parcel/address. Can cross-reference with the GCWW lead service line information.

# VACANT BUILDINGS WITH KNOWN LSL

20 neighborhoods with highest percentage of full LSL



# *EXAMPLE: WEST PRICE HILL*

- Active services: ~6000
- Vacant properties: ~212
  - 117 have LSL (full or partial)
    - 112 are residential – one, two, or three family
    - 2 apartment buildings
    - 1 ‘Charity, Hospital, Retirement’
    - 1 commercial – small retail

Work in progress – assessing length of time of vacancy

# CONCLUSIONS

- Short-term (days to weeks) stagnation does not appear to have adverse effect.
- Relatively conservative water usage (50 gpd, maybe 10 gpd?) enough to maintain a previously well-developed  $\text{PbO}_2$  scale.
- Long term (months to years) stagnation at  $<3$  gpd can result in electrochemical reduction of  $\text{Pb(IV)}$  scale, due to lowering of ORP and surface corrosion potential in the scale microenvironment.
- Triggered by eventual loss of chlorine residual in the LSL.
- $\text{PbO}_2$  scale reduced to  $\text{Pb(II)}$  phases (e.g., cerussite or hydrocerussite, depending on specific water chemistry).

# *CONCLUSIONS*

- Cities with Pb(IV) scale need to be aware of the pool of vacant/foreclosed buildings with LSL.
- Recommend that reoccupied long-term vacant homes have water tested.
- Assuming that no other water quality issues exist, the problem should be reversible once regular, consistent use is re-established.
- Time frame and amount of water needed to re-form PbO<sub>2</sub> scale is currently under investigation.

# *ACKNOWLEDGEMENTS*

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# *DISCLAIMER*

## **Notice**

*The findings and conclusions in this presentation have not been formally disseminated by the U.S. Environmental Protection Agency and should not be construed to represent any Agency determination or policy. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use*

*THANK YOU!*

**Michael DeSantis**

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