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Part 2: Corrosion Control Desktop Studies - Putting the Tools to Use

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PNWS-AWWA

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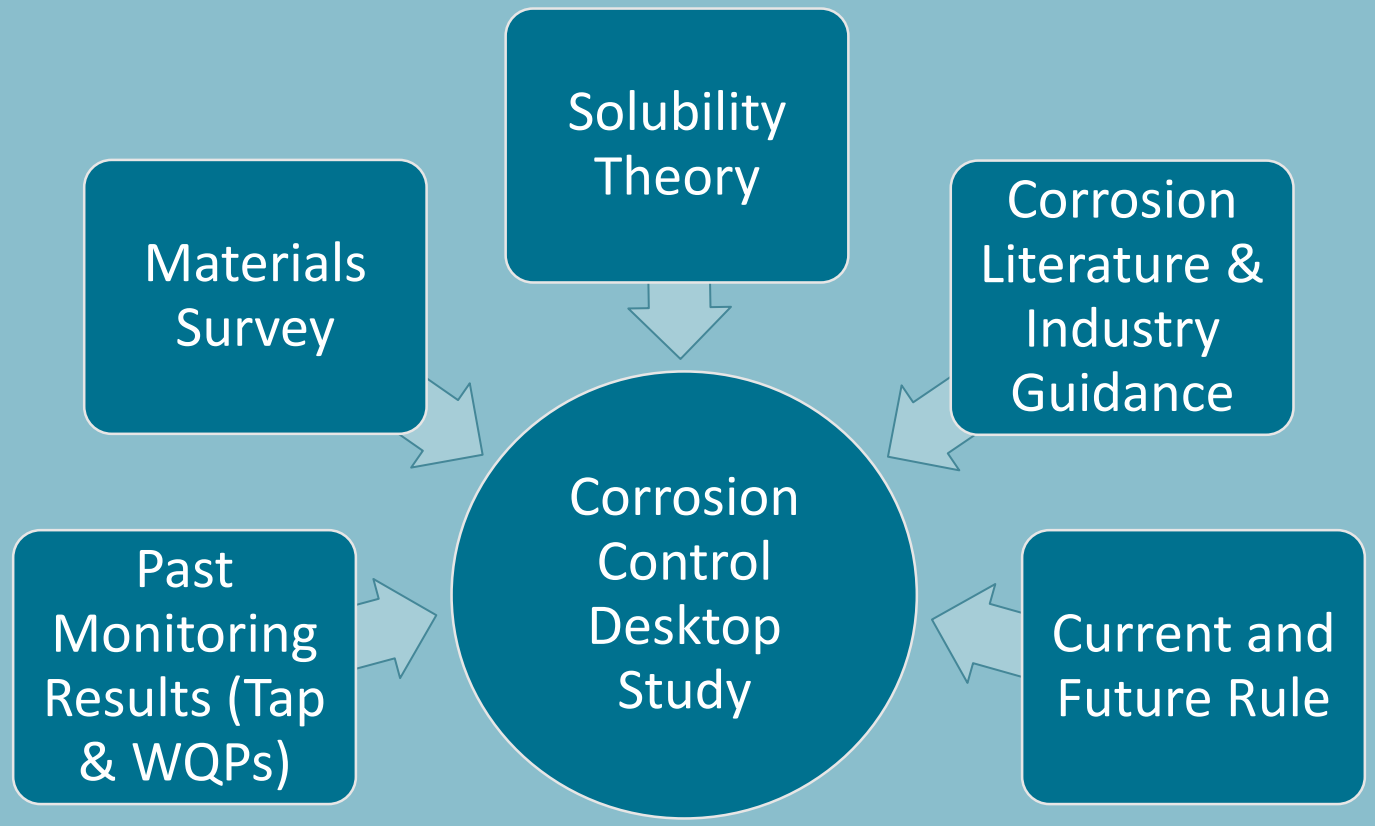
Vancouver, WA
May 3, 2019

Corrosion Control Evaluation - Approach

DATA

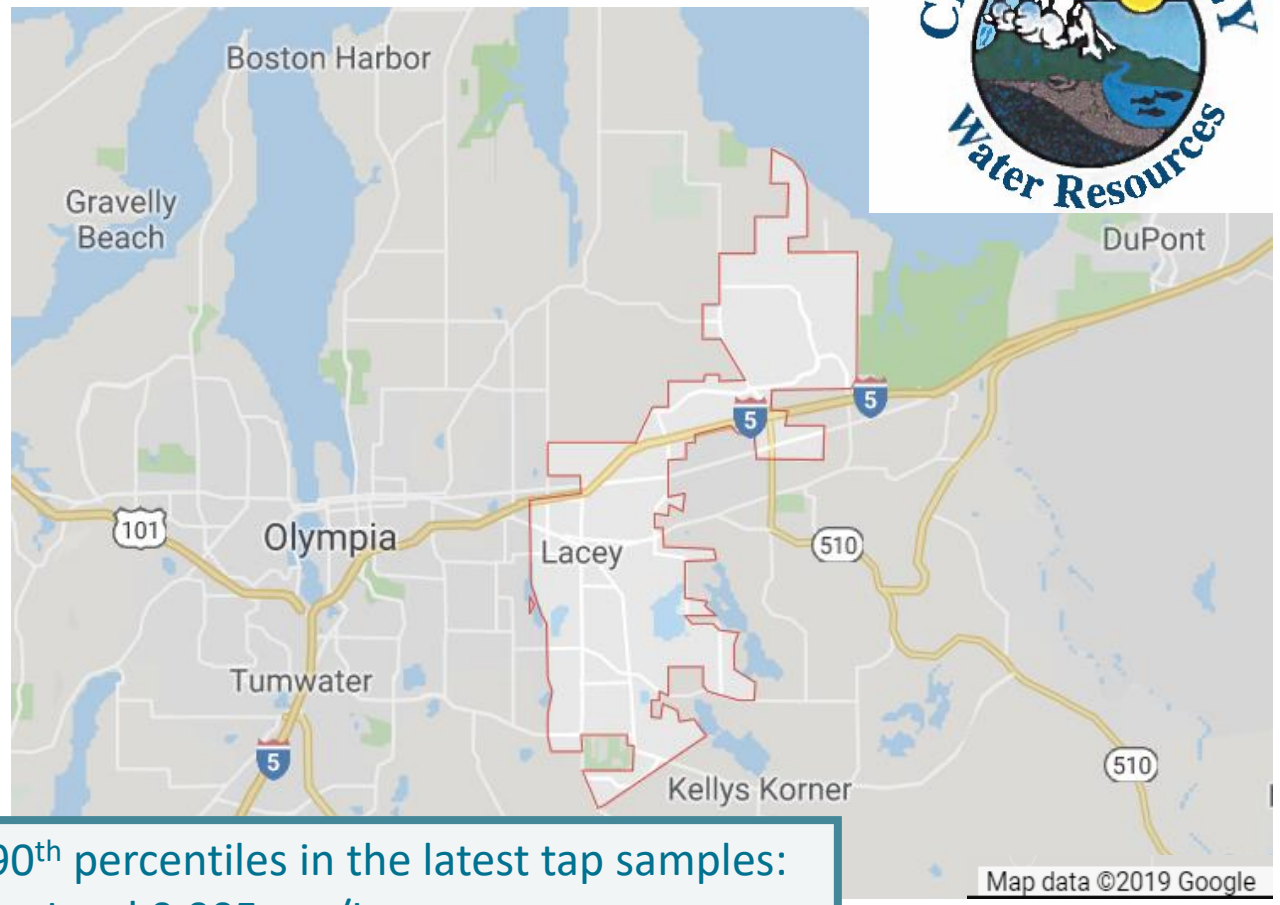
TOOLS

EXPERIENCE



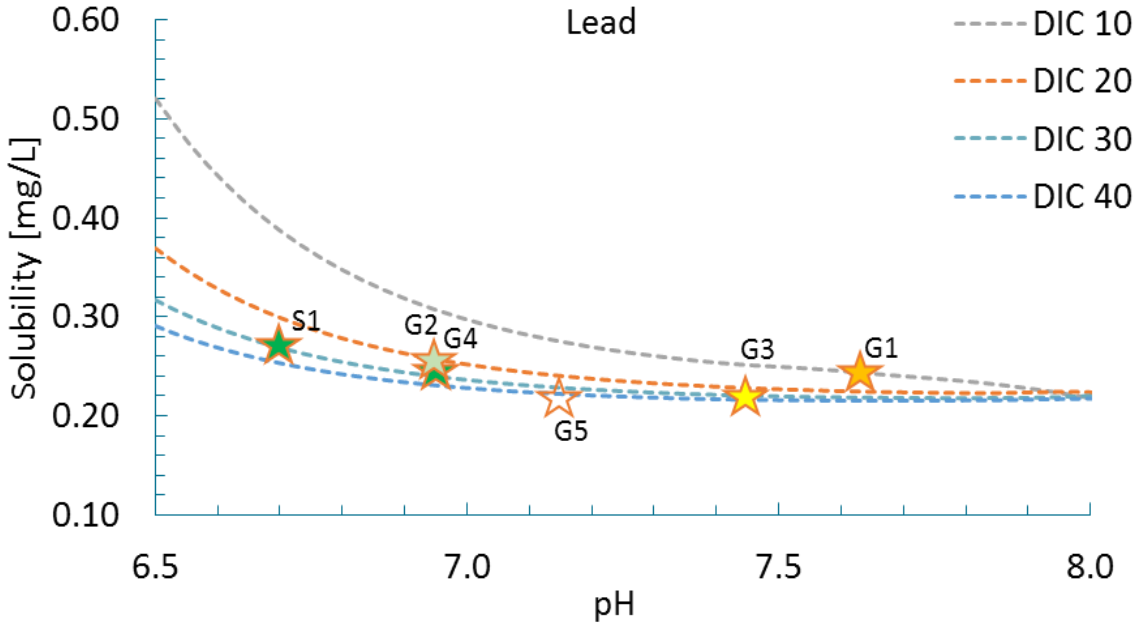
Case Study 1: City of Lacey – multiple groundwater wells

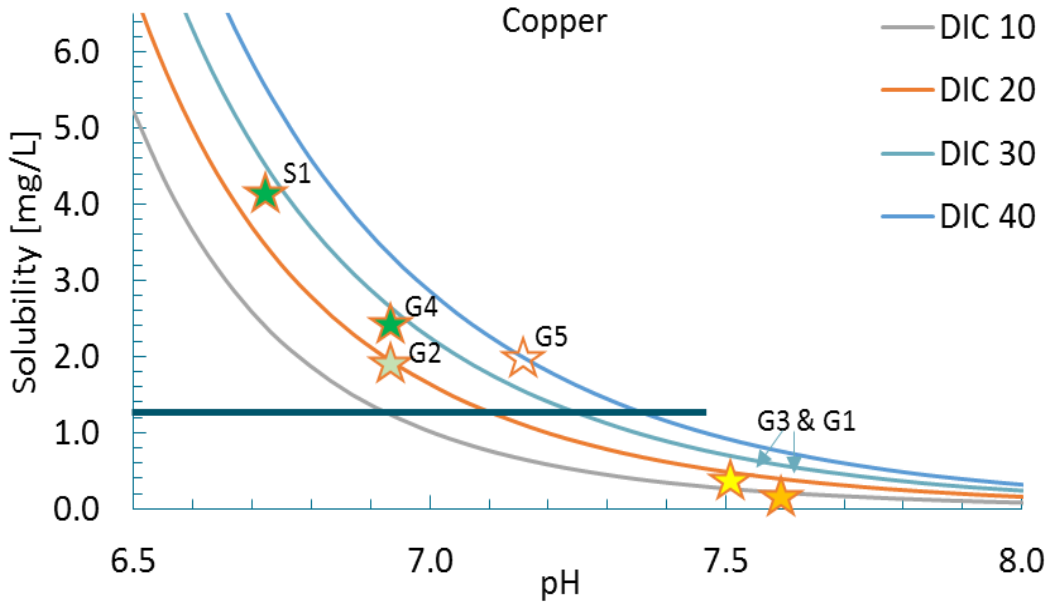
- Serves >50,000 people
- 19 active groundwater wells
  - One well has caustic soda treatment for pH adjustment
  - Three wells treated to remove Fe/Mn
  - Hypochlorite injection at all wells
- No lead service lines (or goosenecks)
- Tier 1 homes have copper plumbing with lead solder
- City completed a year of water quality parameter monitoring (twice)



90th percentiles in the latest tap samples:
- Lead 0.005 mg/L
- Copper 0.69 mg/L

Case Study 1: City of Lacey





Group	Sources	DIC mg/L as C	pH s.u.	TDS mg/L	Ca mg/L	ALK mg/L as $CaCO_3$
G1	9, 32	10-11	7.6-7.7	57-59	21-25	40-43
G2	20,23,24,25,27,28	15-21	6.9-7.0	59-97	36-55	55-67
G3	4,7,10	17-22	7.4-7.5	83-102	42-52	64-83
G4	6,17,18	24-30	6.9-7.0	93-132	47-80	76-98
G5	29	40	7.15	181	116	140

CITY OF LACEY
Water Resources

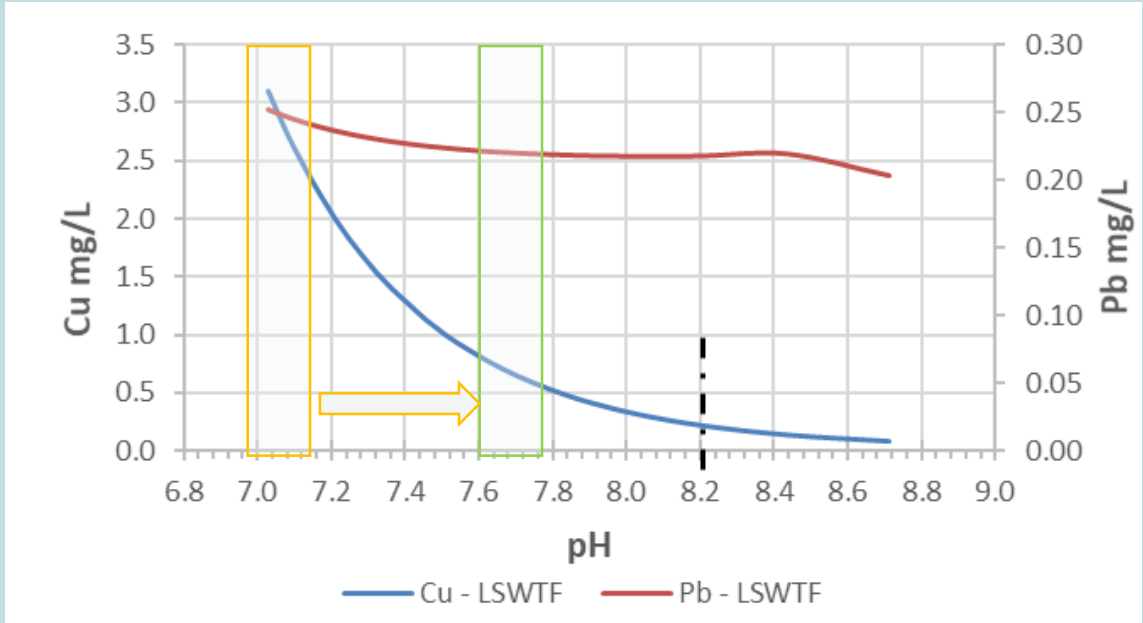
Case Study 1: City of Lacey

- Lead solubility flat lines pH > 7.0 – no benefit from increased pH.
  - **Optimal lead control is achieved at pH ≥ 7.0**
- Copper solubility could be reduced by increasing the pH.
  - **Homes with newer copper plumbing should be supplied water with pH ≥ 7.2**
- Recommended approach:
  1. Increase the pH of the highest capacity and most corrosive sources that serve Tier 1 homes to ensure pH ≥ 7.0 in distribution system
  2. Next priority level are sources that supply newer homes with copper piping.
     - Treatment target pH ≥ 7.4
     - Distribution target pH ≥ 7.2

Case Study 2: Snohomish County PUD #1 – Lake Stevens

- Serves ~50,000 people
- City of Everett Wholesale customer
- Two groundwater wells
  - chlorination & Fe/Mn removal through pressure filters
- No lead service lines or goosenecks
- Tier 1 homes have copper plumbing with lead solder
- Data from ongoing water quality monitoring program

Project Scope: Optimal Corrosion Control for the Groundwater Wells (LSWTF)



SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

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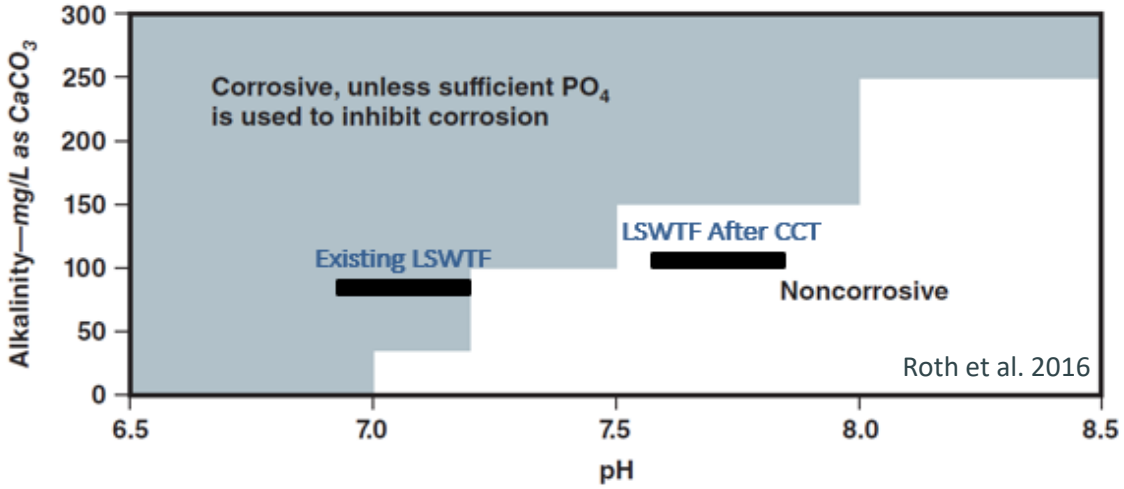
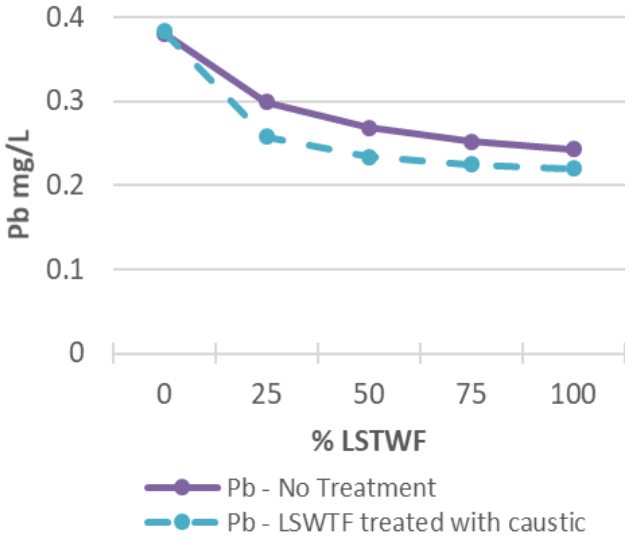
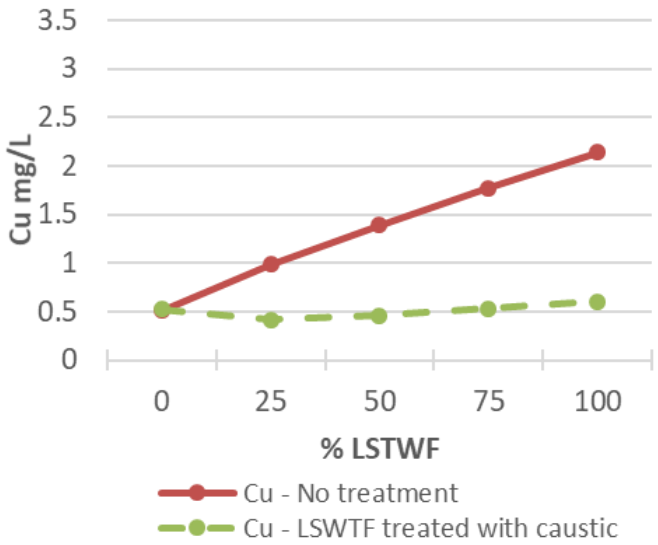
Case Study 2: Snohomish County PUD #1 – Lake Stevens

Caustic treatment to increase pH to 7.6 recommended to address copper corrosion and to achieve more balanced water chemistry







Case Study 3: City of Camas, Collaboration Project with Carollo Engineers, inc

- Medium size system that exceeded copper action level in 1993
- Six groundwater wells – finished water pH target 7.2
  - Caustic soda treatment (except Well 9)
- Surface water supply
  - New treatment plant - slow sand filter
  - Winter source only (Nov – May)
  - Previous plant included soda ash treatment for corrosion control
- Project scope to provide corrosion assessment for the new slow sand filtration plant

City of Camas WASHINGTON

carollo

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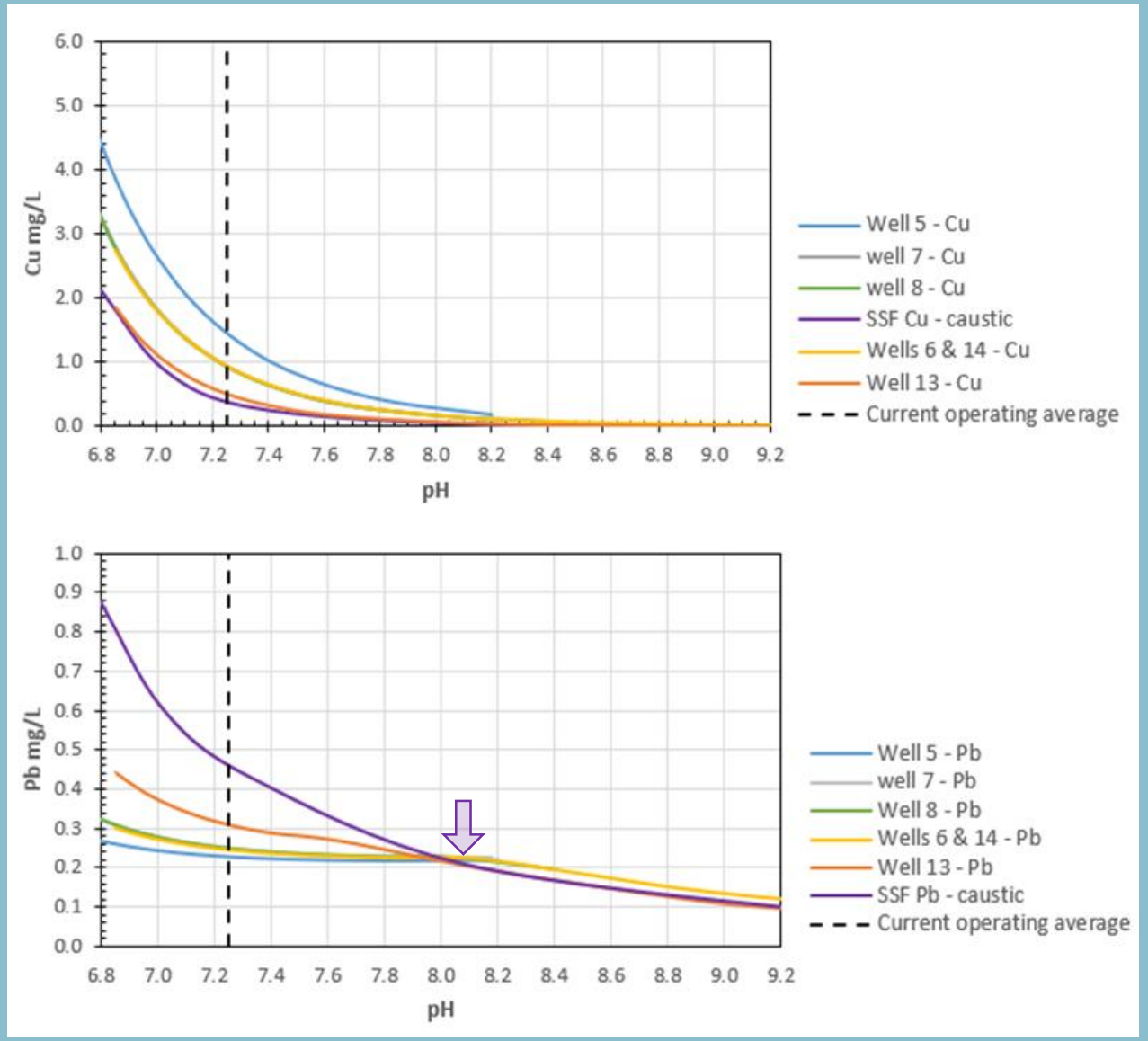
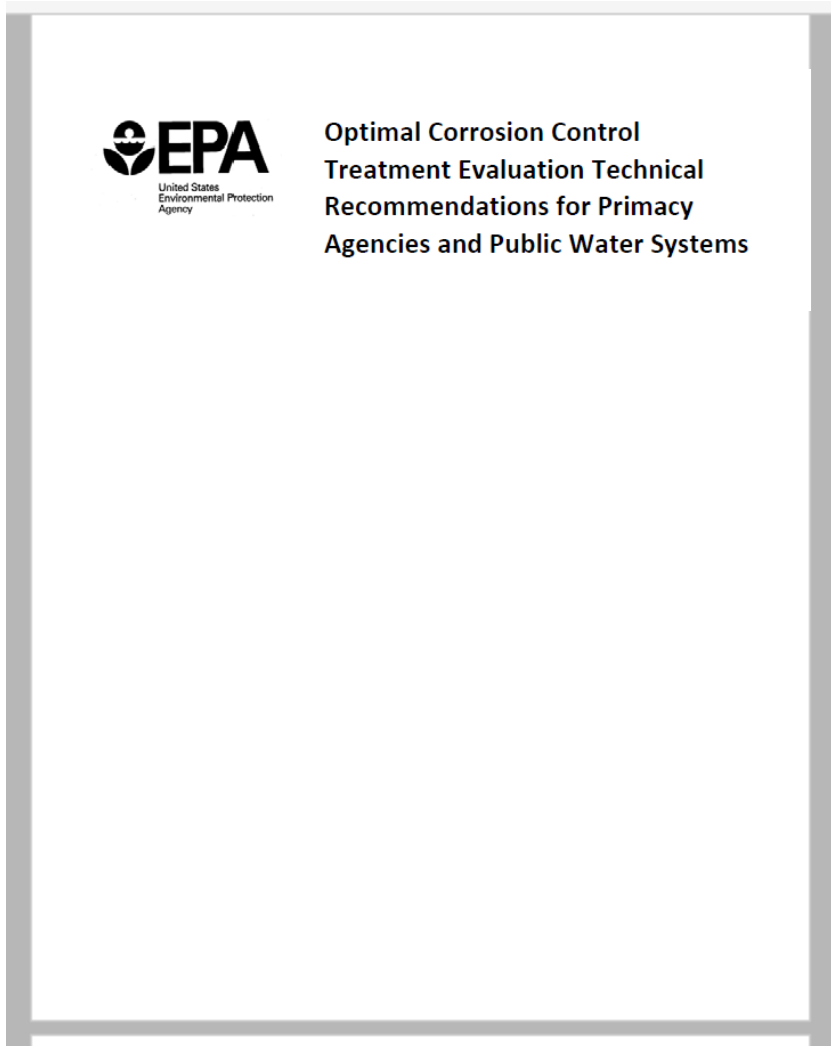
Case Study 3: City of Camas

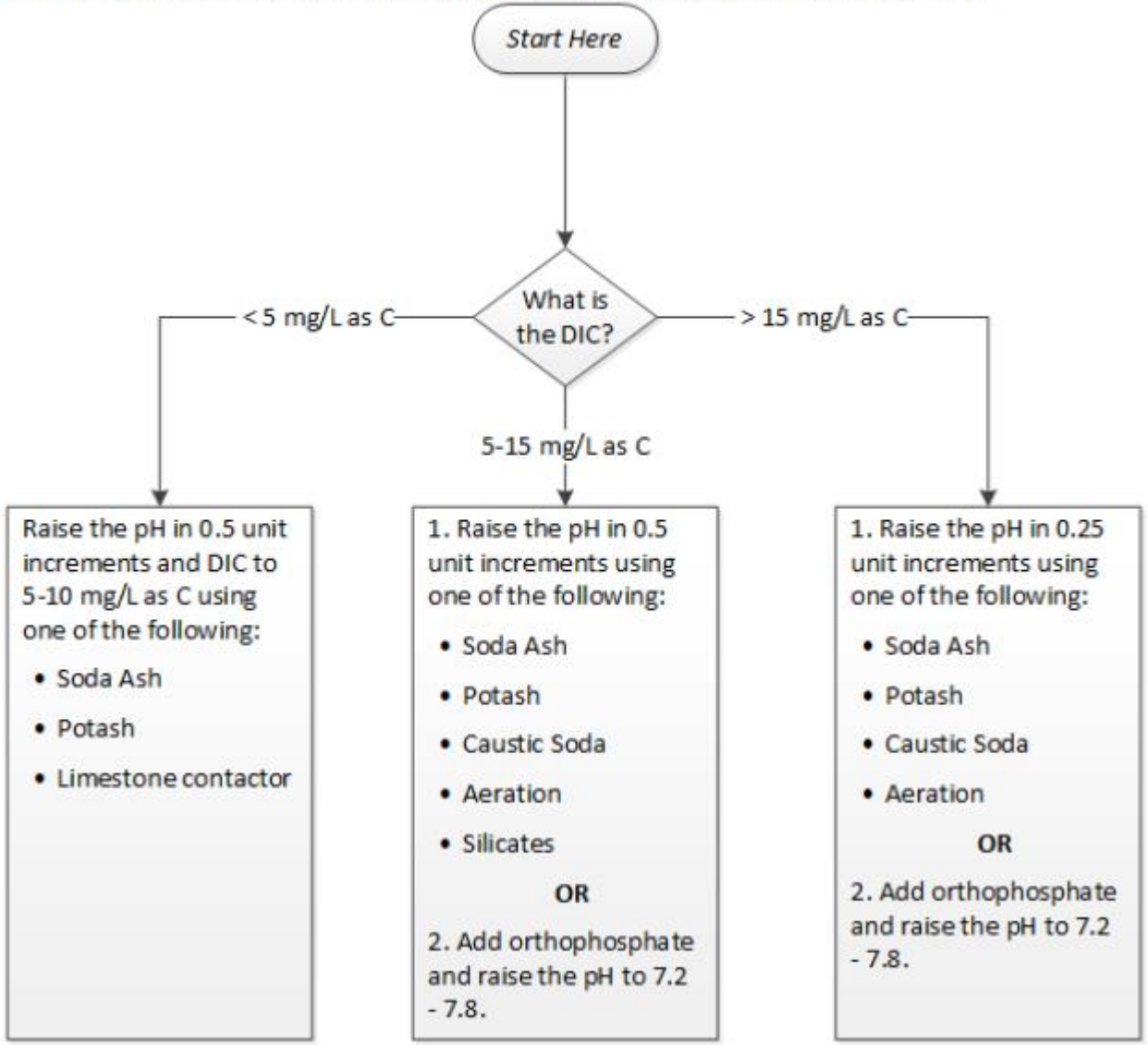
Parameter	SSF Water Quality
pH	7.13
Temperature	9.2 °C
TDS	59 mg/L
Alkalinity	6.3 mg/L as CaCO3
DIC	1.8 mg C/L
Calcium	1.3 mg/L
Magnesium	0.3 mg/L
Chloride	1.3 mg/L
Sulfate	0.4 mg/L



Treatment Selection



Flowchart 1a: Selecting Treatment for Lead only or Lead and Copper with pH < 7.2

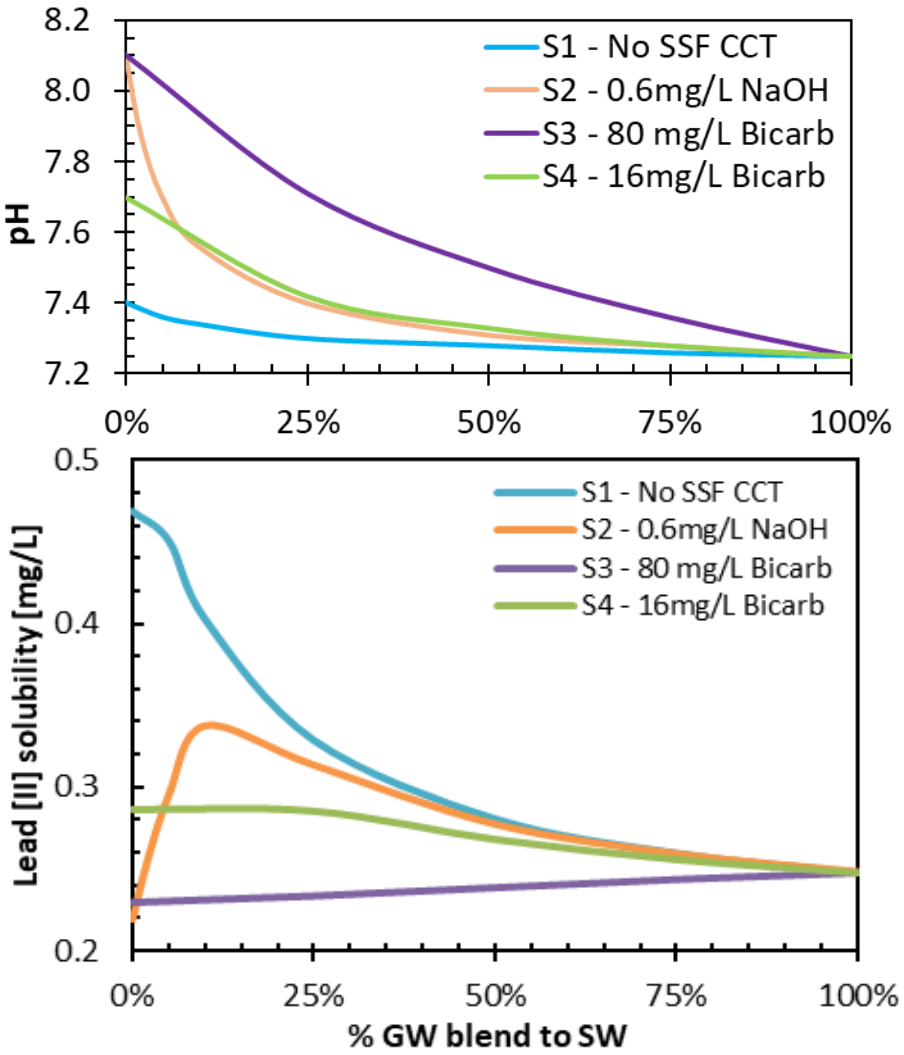


EPA OCCT Guidance
March 2016

Case Study 3: City of Camas

	S1	S2	Not graphed	S3	S4
Treatment*	No CCT	0.6mg/L NaOH	1.3 mg/L Soda ash	80 mg/L Bicarb	16mg/L Bicarb
pH	7.4	8.1	8.1	8.2	7.7
Alkalinity	6.9	7.5	8.1	54.5	16.4
DIC	1.8	1.8	2.0	13.3	4.1

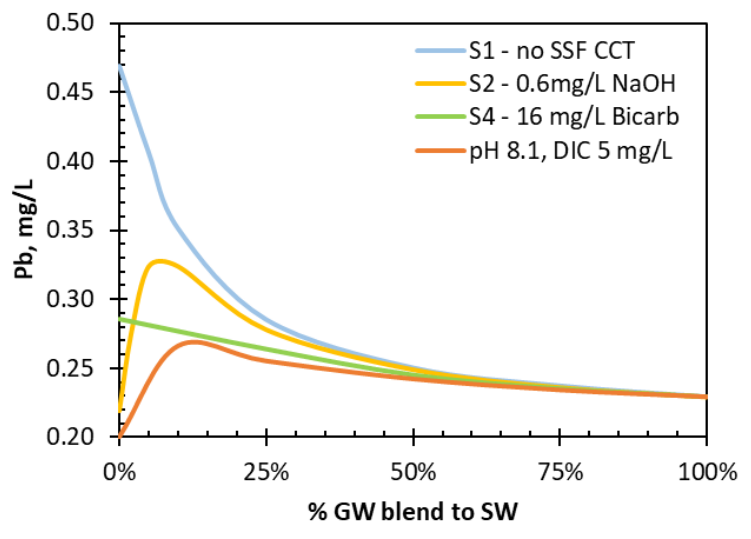
* All include 1.0mg/L NaOCl dose

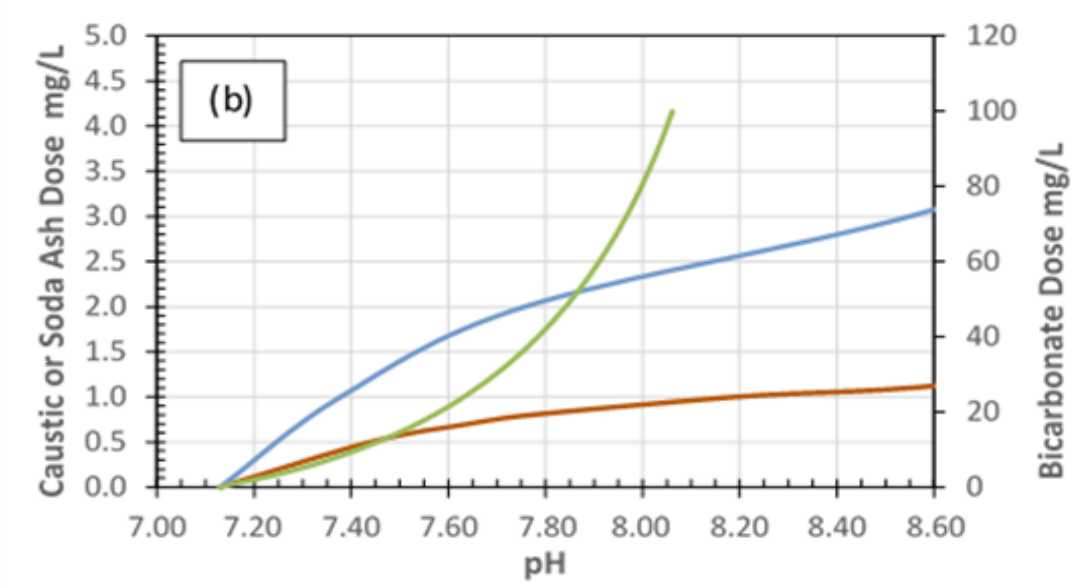


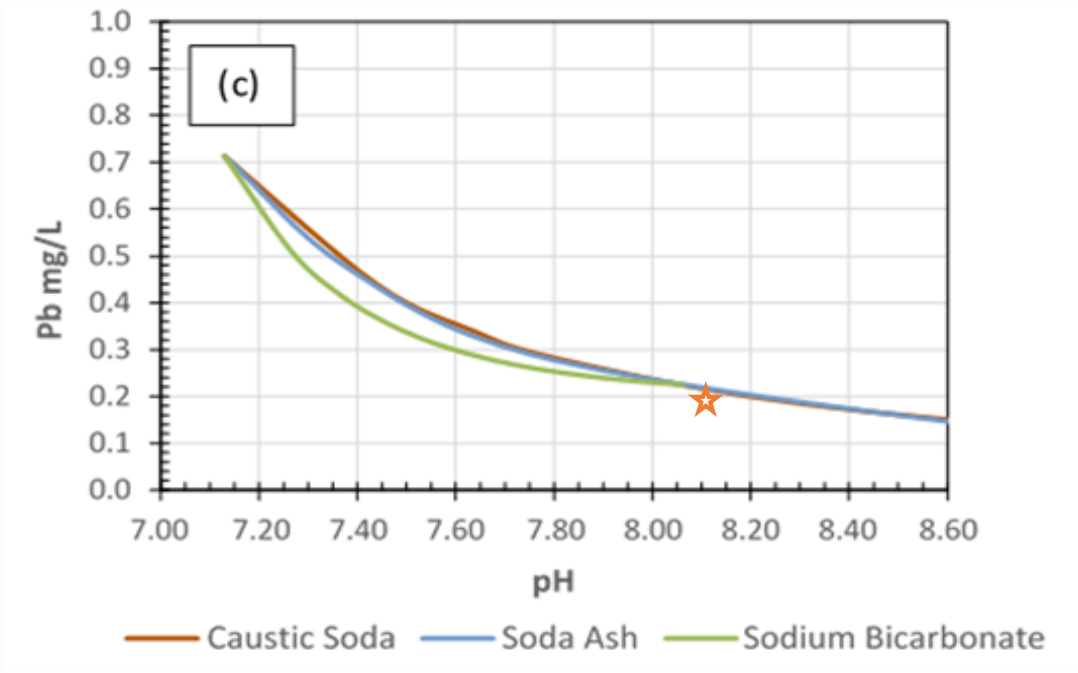
Case Study 3: City of Camas

- Adjust pH > 8.0 and alkalinity ~ 20mg/L as $CaCO_3$ to get to DIC 5 mg C/L
- Chemical choices driven by
  - Cost
  - Availability
  - Operator preference & experience
  - Safety
  - and many other factors

  ...but not by the chemistry







Corrosion Control Evaluation - Approach

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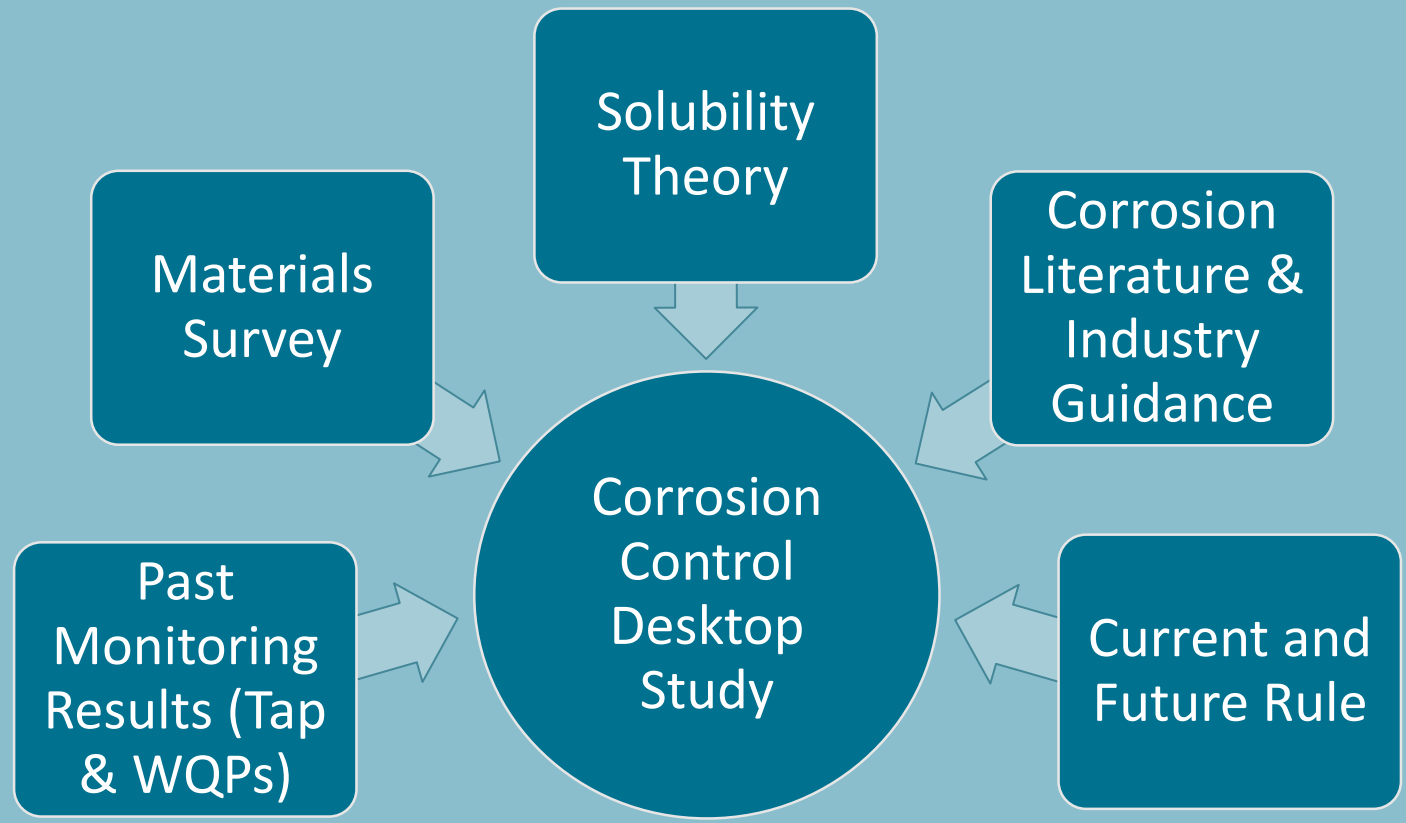
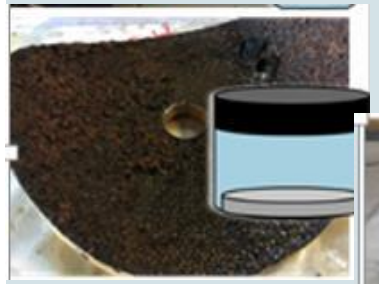
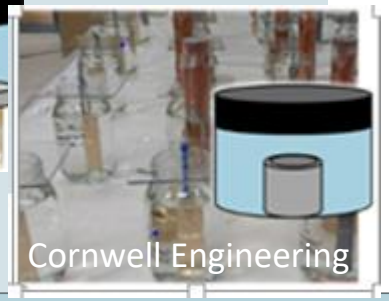


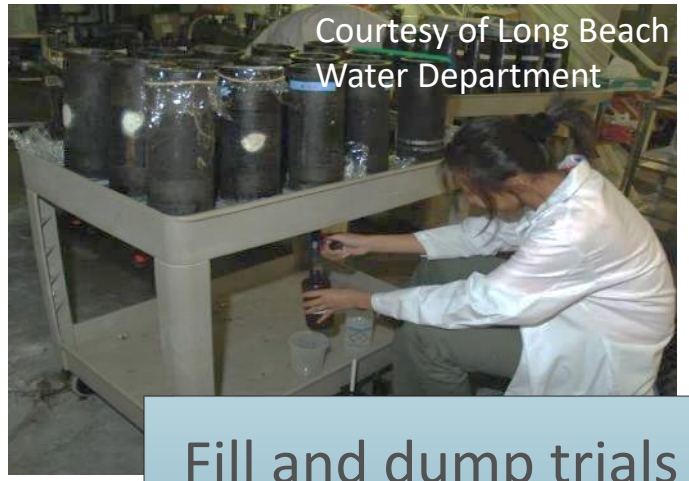
Other Tools – when desktop isn't enough:





Bench-Scale Coupons

PRS station



Fill and dump trials

Flow-through material rigs

Flow-through pipe segments

Process Research Solutions (PRS) Station

Target

- Lead and copper rule compliance
- Assess impacts of treatment changes and blending on lead and copper solubility
- Assess impacts of ramp up approach

Approach

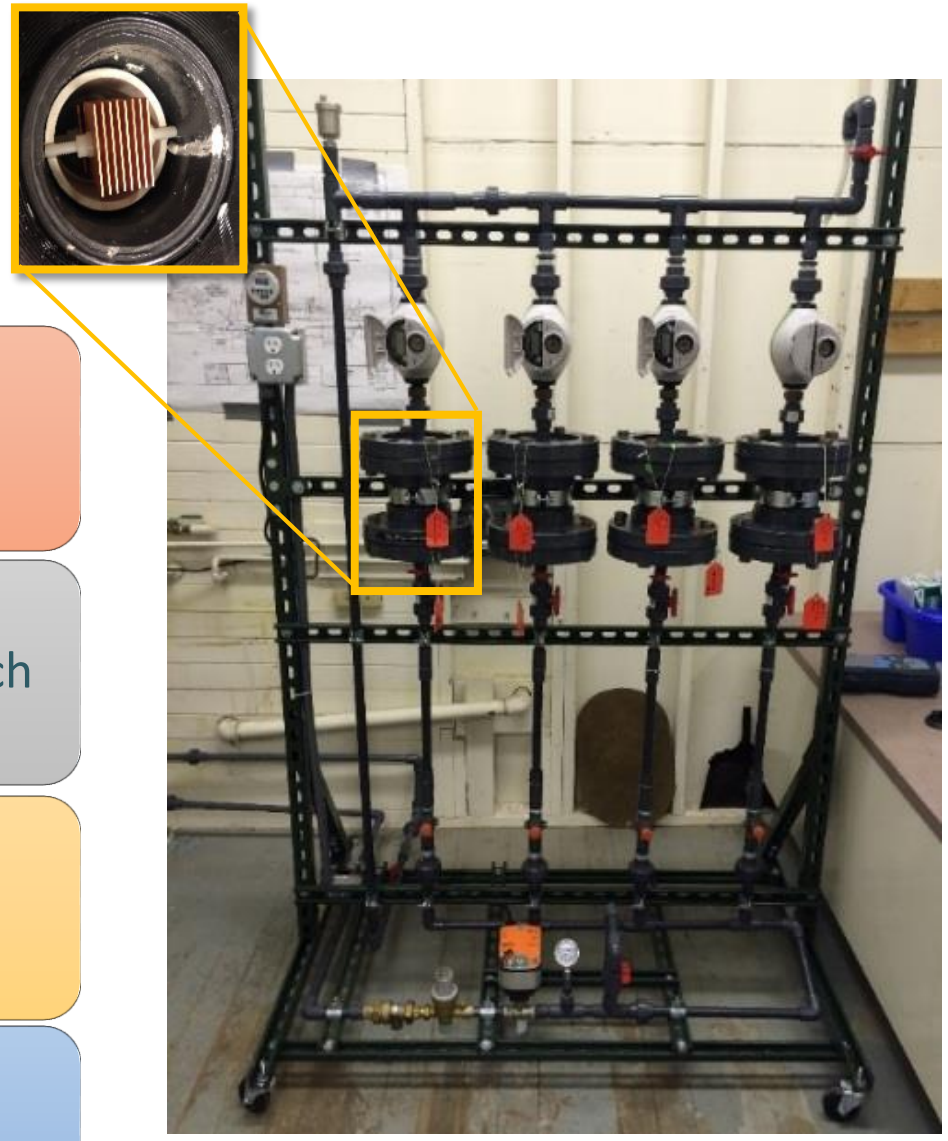
- Off-the-shelf set up for 2 and 4 chambers, coupons can be lead, copper, copper/lead solder, brass, or galvanized
- New metal surfaces exposed to the prevailing water

Pros

- Installed in distribution system – captures actual WQ conditions
- Assess WQ changes over time (flowing and stagnation)
- Proven technique

Cons

- Represents new metal surfaces, not aged premise plumbing
- Requires routine sample collection and operations
- Water flows to waste, requires housing, etc.



Fill and Dump Trials

Target

- Release of iron, manganese, arsenic, chromium, etc. from existing pipe scales under different water quality conditions
- Scale stability, metals release, tendency to cause discolored water event

Approach

- Controlled fill/stagnation/dump cycles
- Harvested pipe specimens from the system (plastic, cast iron, cement lined, galvanized)
- Expose the pipe to different water quality conditions

Pros

- Can account for existing scales and potential metal/trace inorganics release
- Ability to test different pipe materials and water quality conditions

Cons

- Requires harvesting pipe sections from distribution system

Acknowledgments

- City of Lacey
- Snohomish PUD – Lake Stevens
- City of Camas and Carollo Engineers, inc

Questions?

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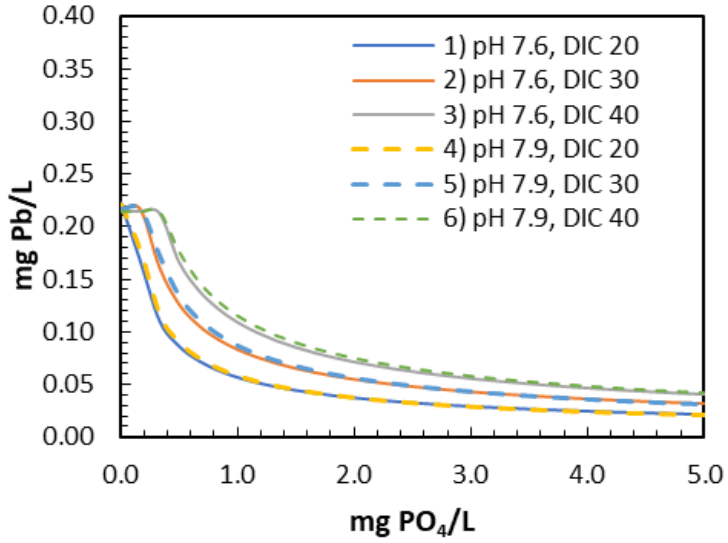
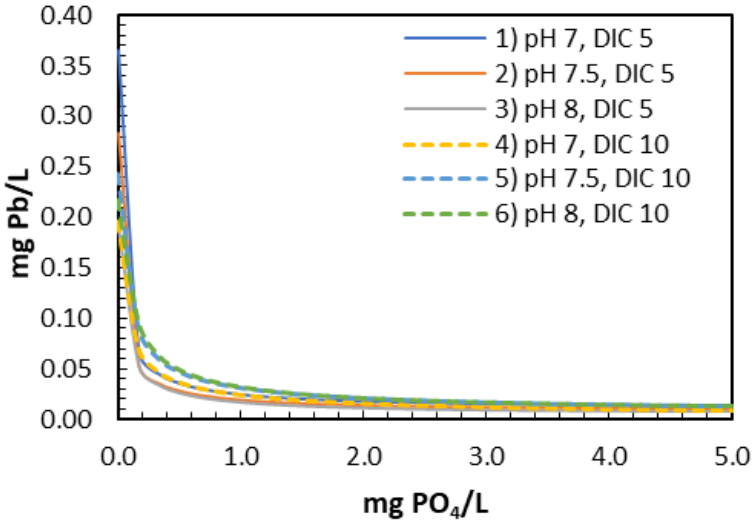
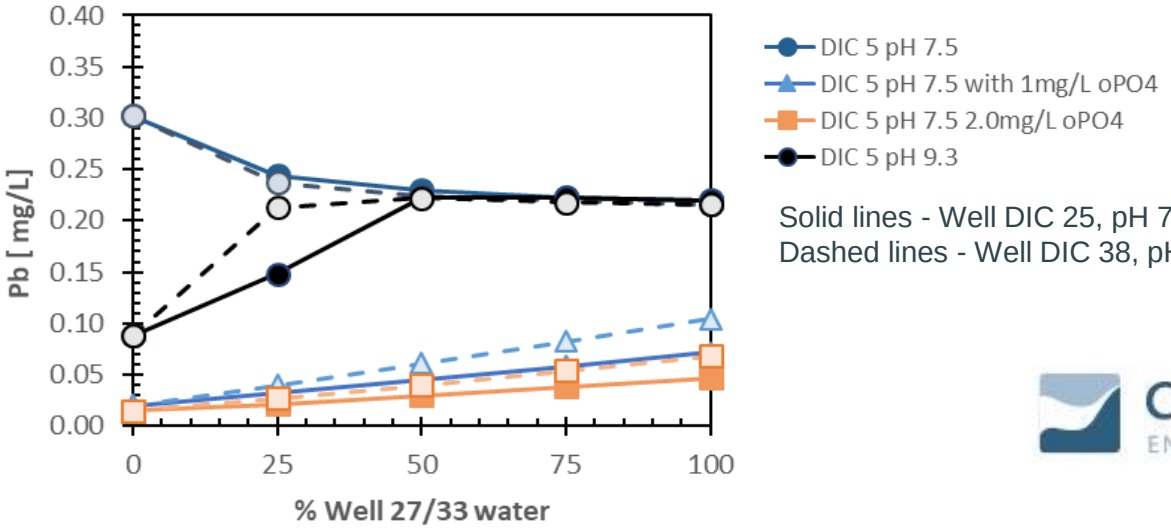
Orthophosphate – Treatment for Lead

- Common in East Coast and Midwest (US) and UK
- Lead materials in the systems
- Lower lead levels with orthophosphate than achievable with pH/Alk adjustment
- Higher dose needed for higher DIC water







Solid lines - Well DIC 25, pH 7.8
Dashed lines - Well DIC 38, pH 7.6

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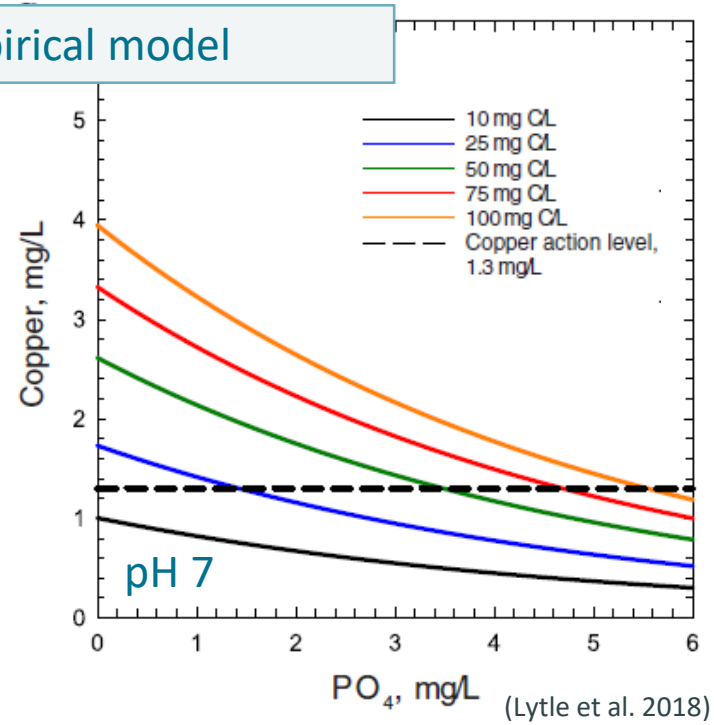
Orthophosphate – Treatment for Copper?

- Benefit for Copper?
  - Recent empirical model (Lytle et al, 2018) suggests yes, but **maybe limited at high pH**
  - Thermodynamic equilibrium based model indicate lower copper solubility with pH/alk adjustment
- Testing would be needed to confirm benefit or increased solubility

Empirical model



(Lytle et al. 2018)

Thermodynamic eq – based solubility model compared with the empirical model