

Results and Implementation of Tacoma Water's Corrosion Control Assessment and Lead Reduction Program



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01 **BACKGROUND**

02 **TEST PLAN**

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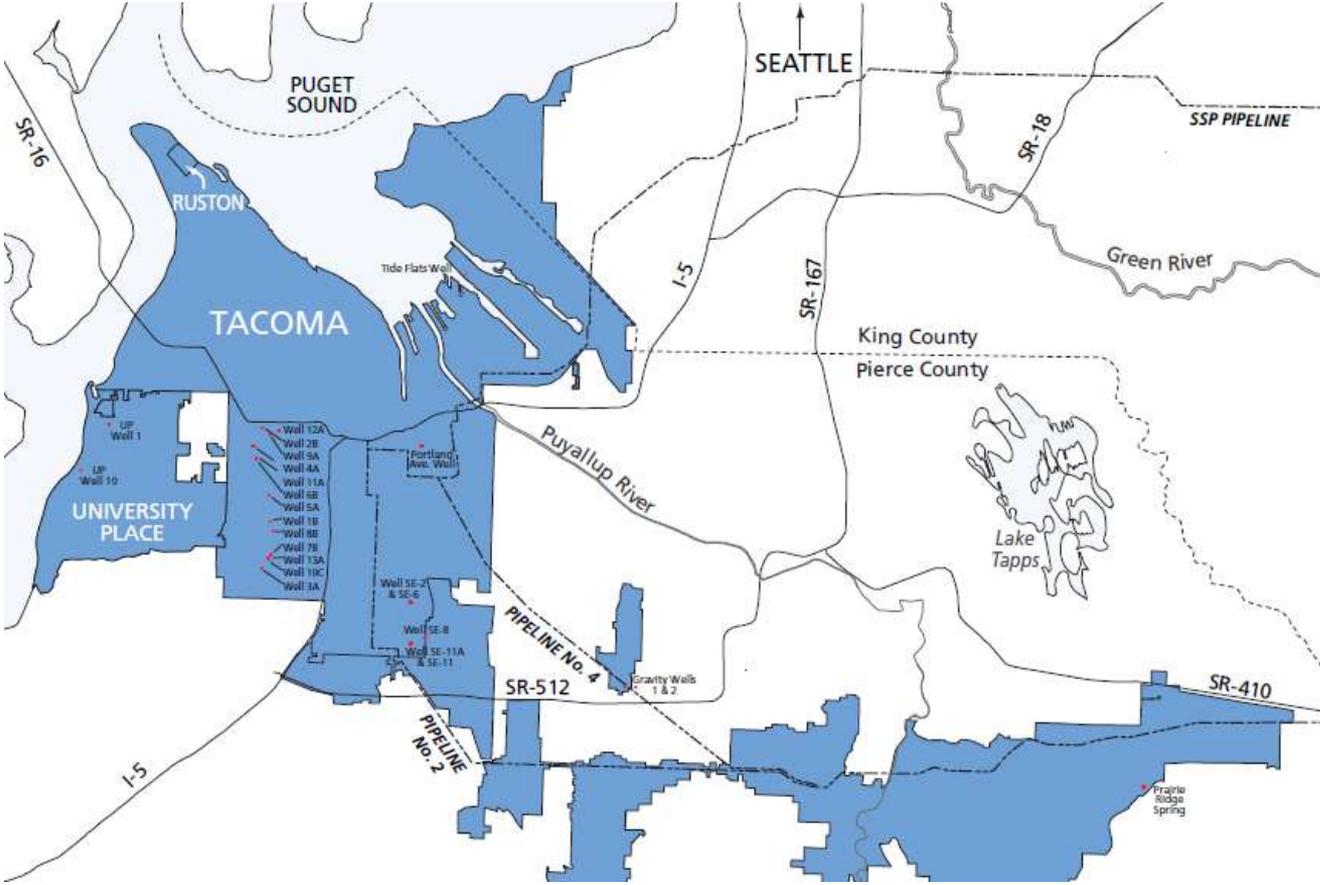


01

BACKGROUND

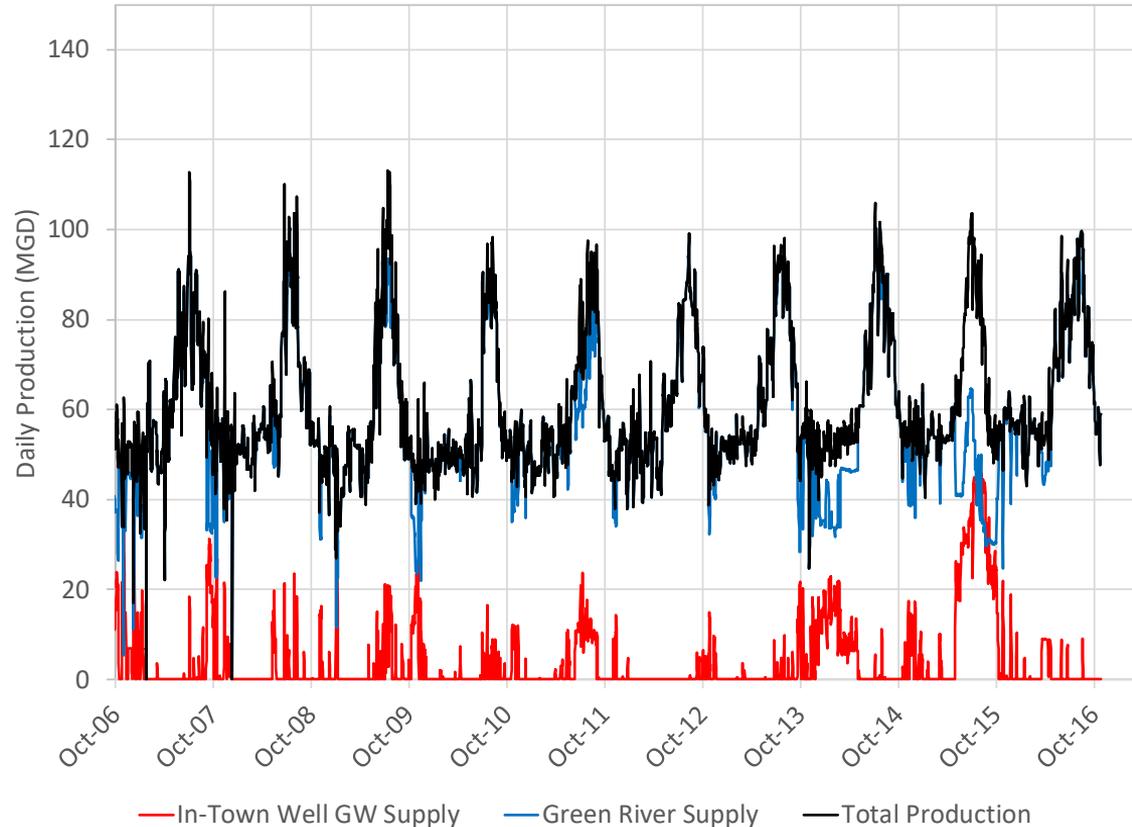
TACOMA WATER SYSTEM

- 150 MGD Green River Filtration Facility
- Multiple wells throughout service area
- Largest is 45 MGD South Tacoma Wellfield.



HISTORICAL WATER SUPPLY

- Primary water supply is surface water.
- Groundwater provides supply flexibility
- Groundwater used for:
 - Smooth out in-town supply operations
 - Drought
 - When Green River is very turbid
 - Other reasons
- Groundwater use is intermittent frequency and variable flows



HISTORICAL LEAD REDUCTION PRACTICES

- 1997 – started adjusting unfiltered Green River pH to 7.5.
- 2014 – started adjusting South Tacoma Wellfield pH to 7.5.
- 2014 – Green River Filtration Facility begins operation. pH adjusted to 7.8 – 8.0.
- 2016 – Green River pH adjusted to 8.2 and alkalinity set to 20 mg/L CaCO₃.
- 2016 – Ramp up ongoing lead gooseneck removal program.

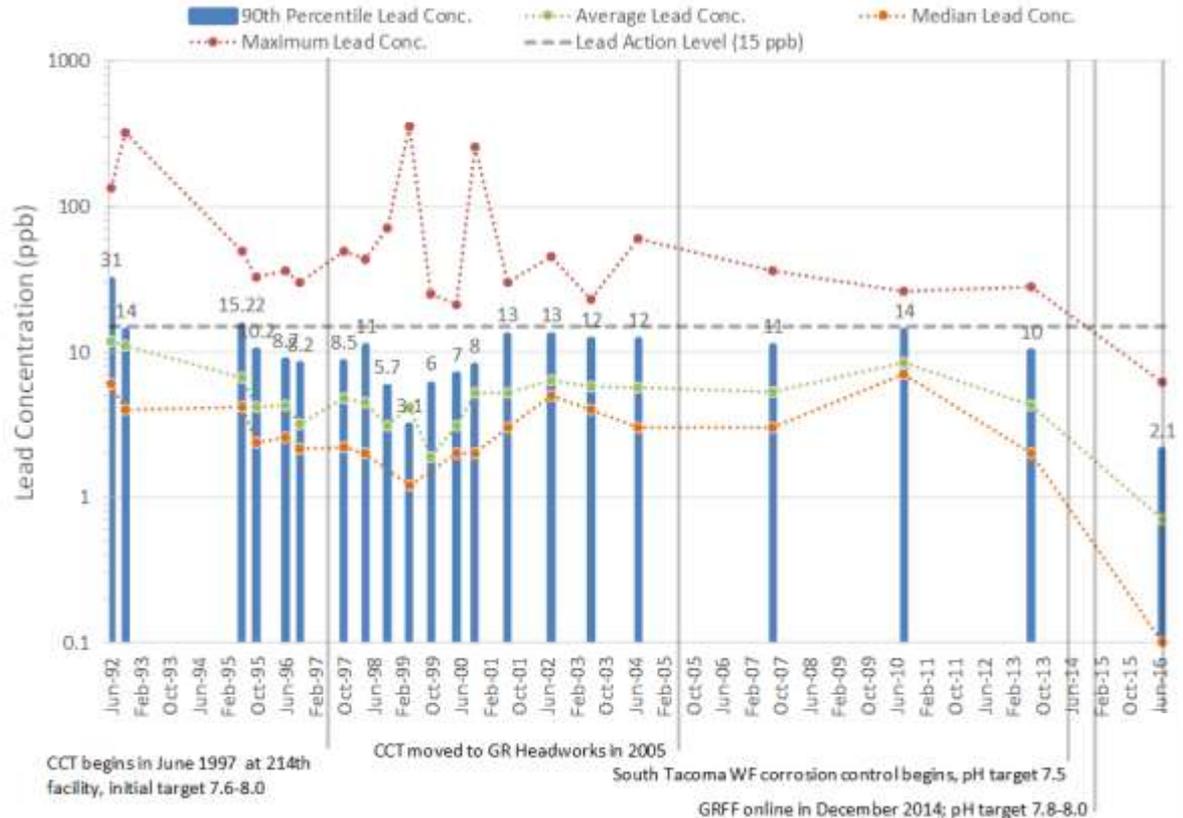
AVERAGE WATER QUALITY

| Untreated Source | pH (standard units) | Alkalinity (mg/L CaCO ₃) |
|------------------------|------------------------|---|
| Green River | 7.6 | 18 |
| South Tacoma Wellfield | 6.7 – 7.2 | 58 – 130 |
| Other In-Town Wells | 6.8 – 7.4 | 56 – 101 |

- Green River – snowmelt fed, lightly mineralized, poorly buffered
- Groundwaters – lower pH, much higher alkalinities

HISTORICAL LEAD RESULTS

- In compliance since 1997
- 90th percentile lead results below, but close to, 15 $\mu\text{g/L}$ action limit.
- Lowest results in 2016 after GRFF online and Green River pH setpoint increased.



NEED FOR RE-ASSESSMENT

- Flint, Michigan events led to increased Tacoma Water commitment to further minimize lead exposure.
- Groundwater corrosion control requirements needed to be defined.
- New Green River Filtration Facility has more tools (i.e. alkalinity adjustment) that prior system did not have.



02 TEST PLAN

PILOT TESTING OVERVIEW

- Test rigs installed at:
 - Portland Avenue Reservoir – control, always supplied Green River water
 - Hood Street Reservoir Chlorine Building – switches between 100% Green River and 100% well water
 - Hood Street Res. Outlet Building – switch between 100% Green River and Green River/well water blend
- Test rigs have:
 - Old Brass meters and assemblies
 - Old copper plumbing
 - Old lead goosenecks



TEST PHASES AT HOOD STREET

| Phase | Dates in 2017 | Water Supply | Target pH |
|-------|--------------------|--------------|-----------|
| 1 | February – April | Green River | 8.2 |
| 2 | April – June | Groundwater | 7.4 |
| 3 | June – July | Green River | 8.2 |
| 4 | July – August | Green River | 8.2 |
| 5 | August – September | Groundwater | 7.8 |

TEST SUMMARY

- Operated continuously for test period
- Water supply on timers to simulate typical residential water use
 - Morning flushing – morning/breakfast water use
 - Mid-day stagnation – sampling after 6 hours
 - Evening flushing – evening/dinner water use
 - Night time stagnation
- Analyzed for typical water quality parameters:
 - Physical parameters – pH, temperature, conductivity, dissolved oxygen, alkalinity
 - Metals – lead, copper, iron, manganese
 - Other – sulfate, chloride, free chlorine

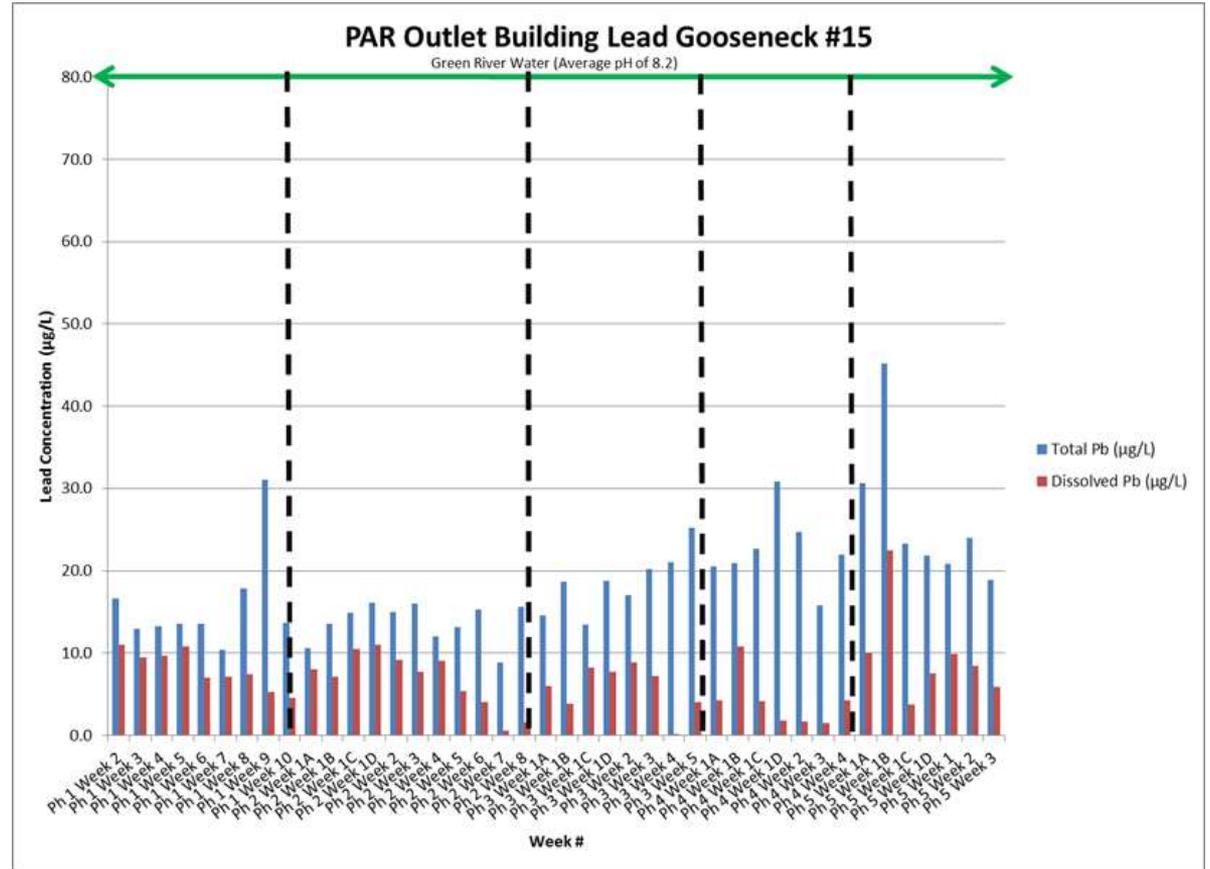


03

RESULTS

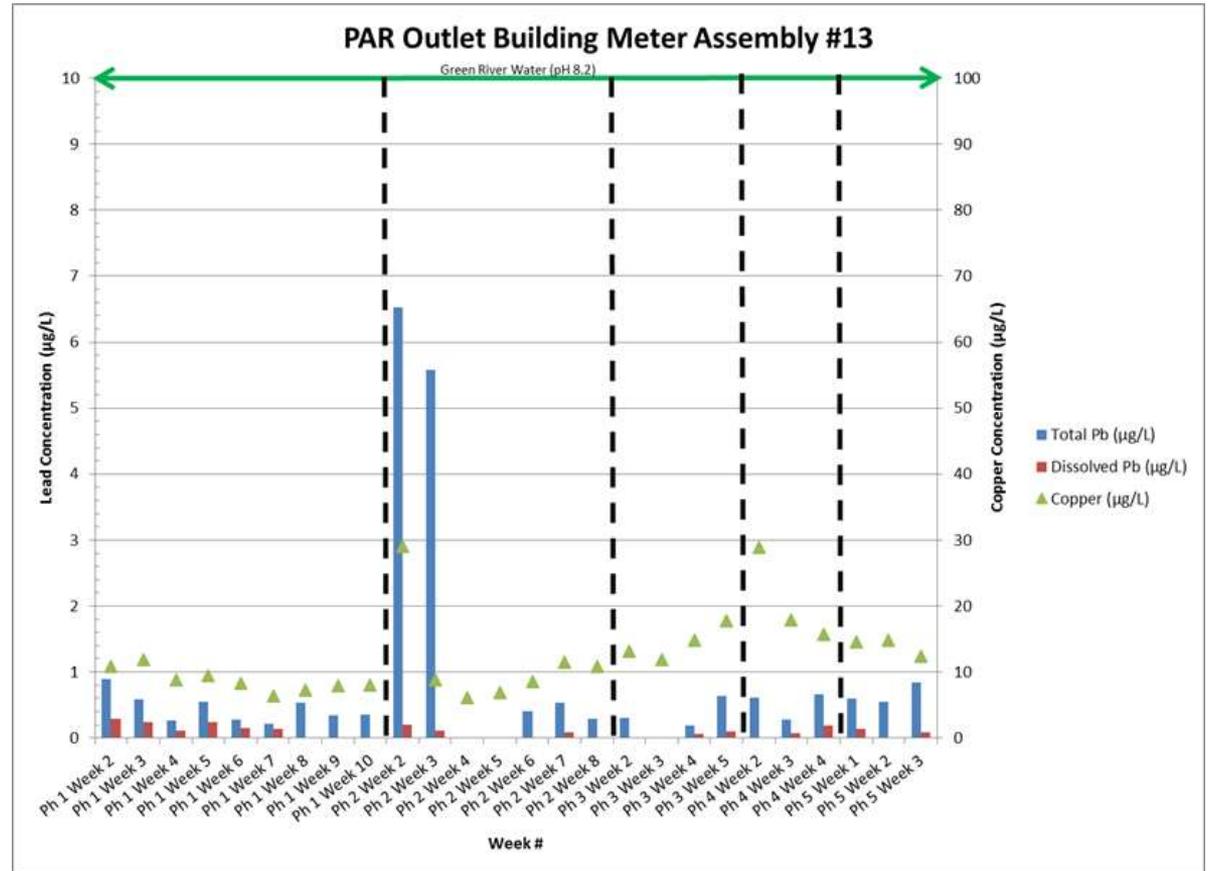
PORTLAND AVENUE RESERVOIR LEAD GOOSENECK

- Control unit – continuously supplied treated Green River at pH 8.2.
- Results shown are for sampling directly from a lead gooseneck
- Very worst-case scenario



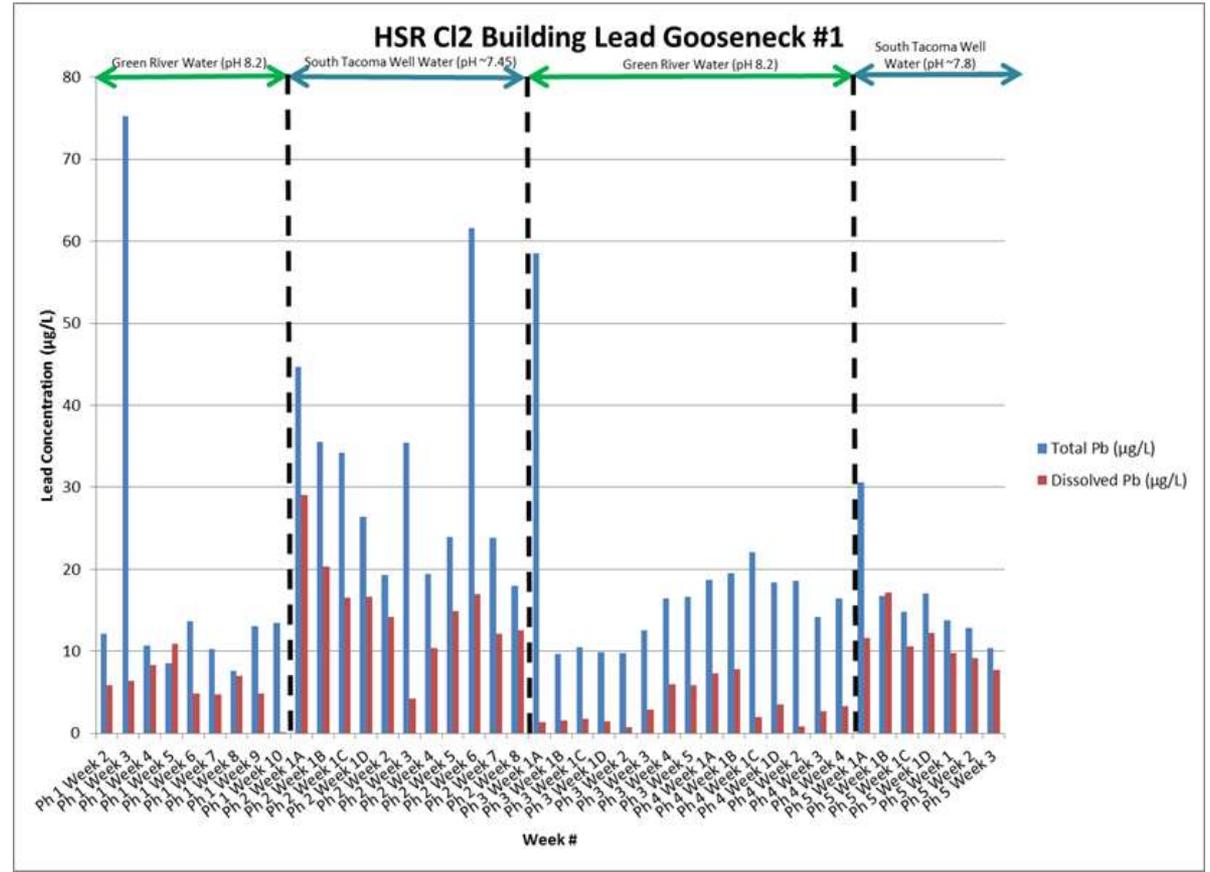
PORTLAND AVENUE RESERVOIR METER ASSEMBLY

- Note that scale stops at 10 $\mu\text{g/L}$ lead and 100 $\mu\text{g/L}$ copper.
- Very low metals release.
- This data represents lead exposure for majority of Tacoma Water customers.



HOOD STREET RESERVOIR INLET LEAD GOOSENECK

- Alternating between:
 - pH 8.2 Green River,
 - pH 7.45 groundwater
 - pH 7.8 groundwater

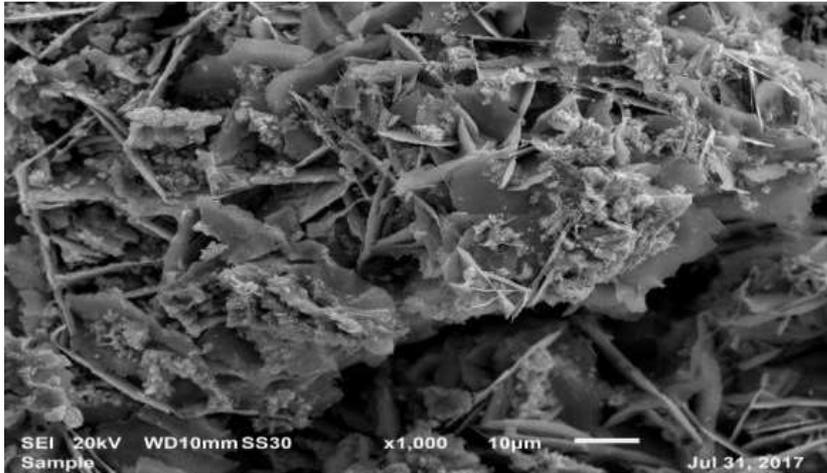


VISUAL COMPARISON OF LEAD GOOSENECK, BRASS CONNECTOR AREA

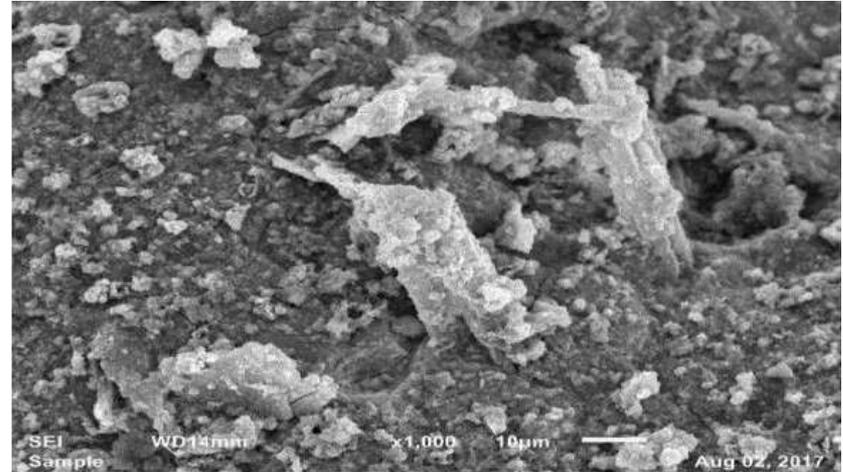


UNIVERSITY OF WASHINGTON SCANNING MICROSCOPY

Pipe samples from pilot rigs

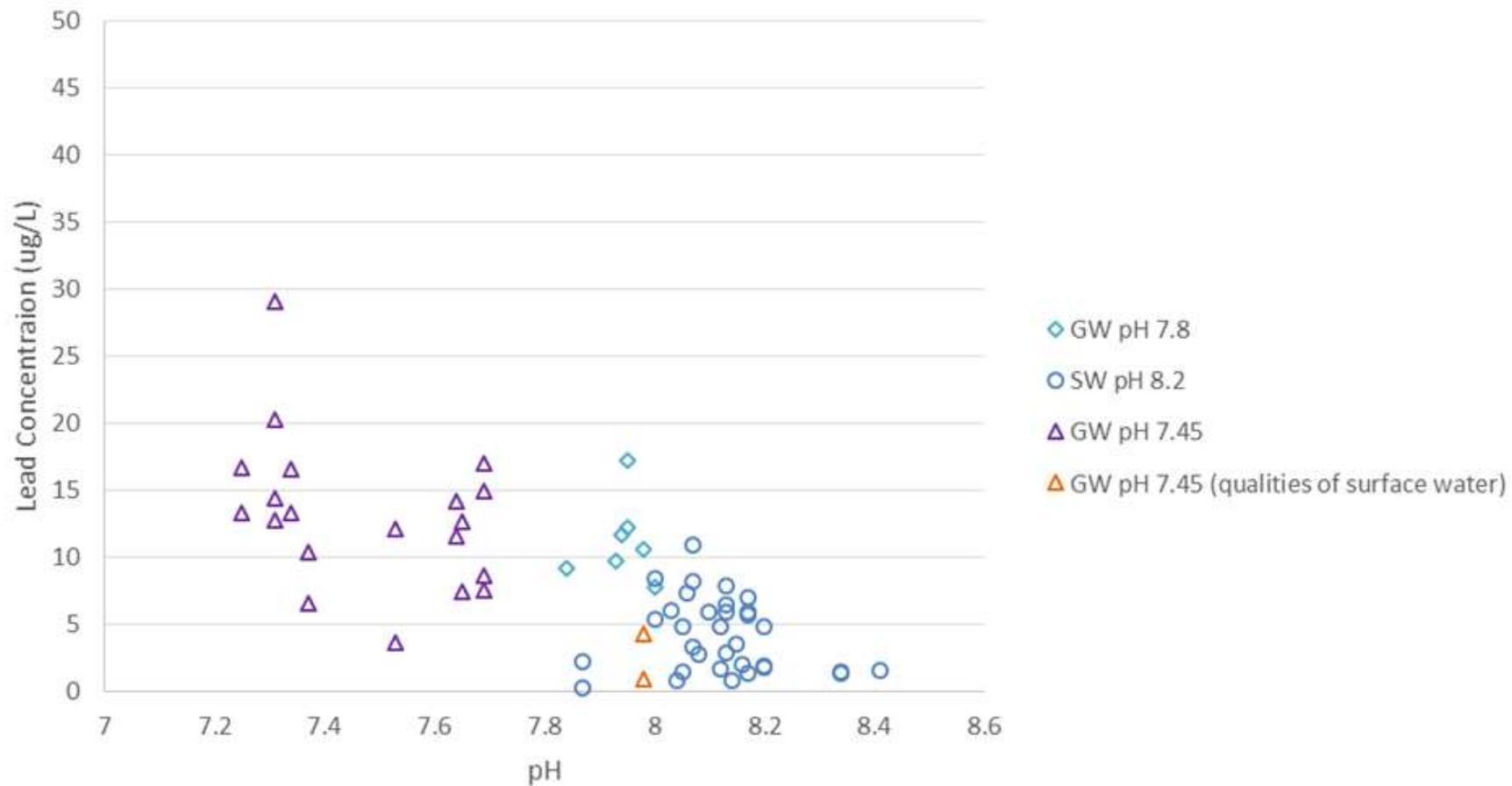


Hydrocerrusite

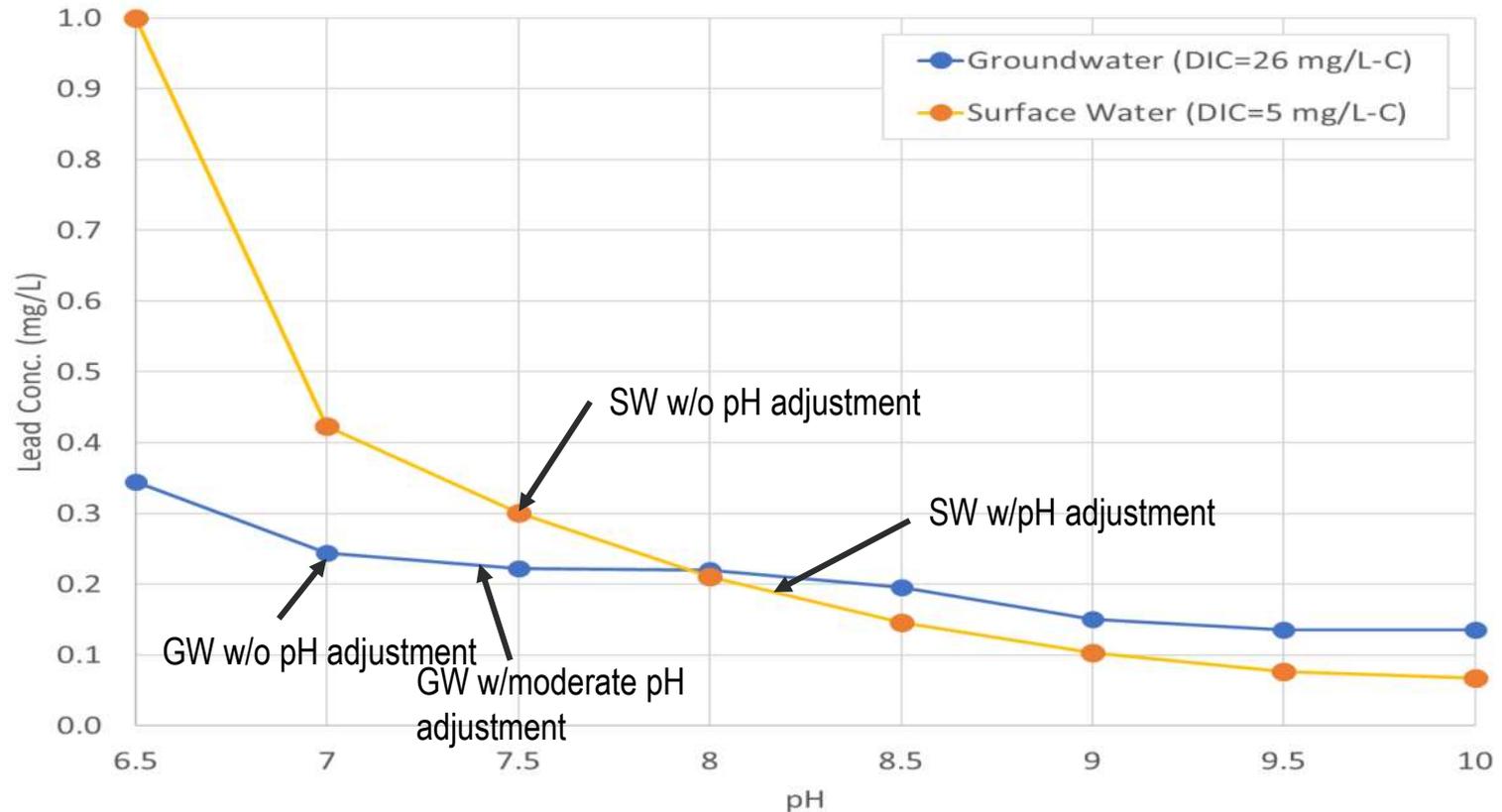


Cerrusite

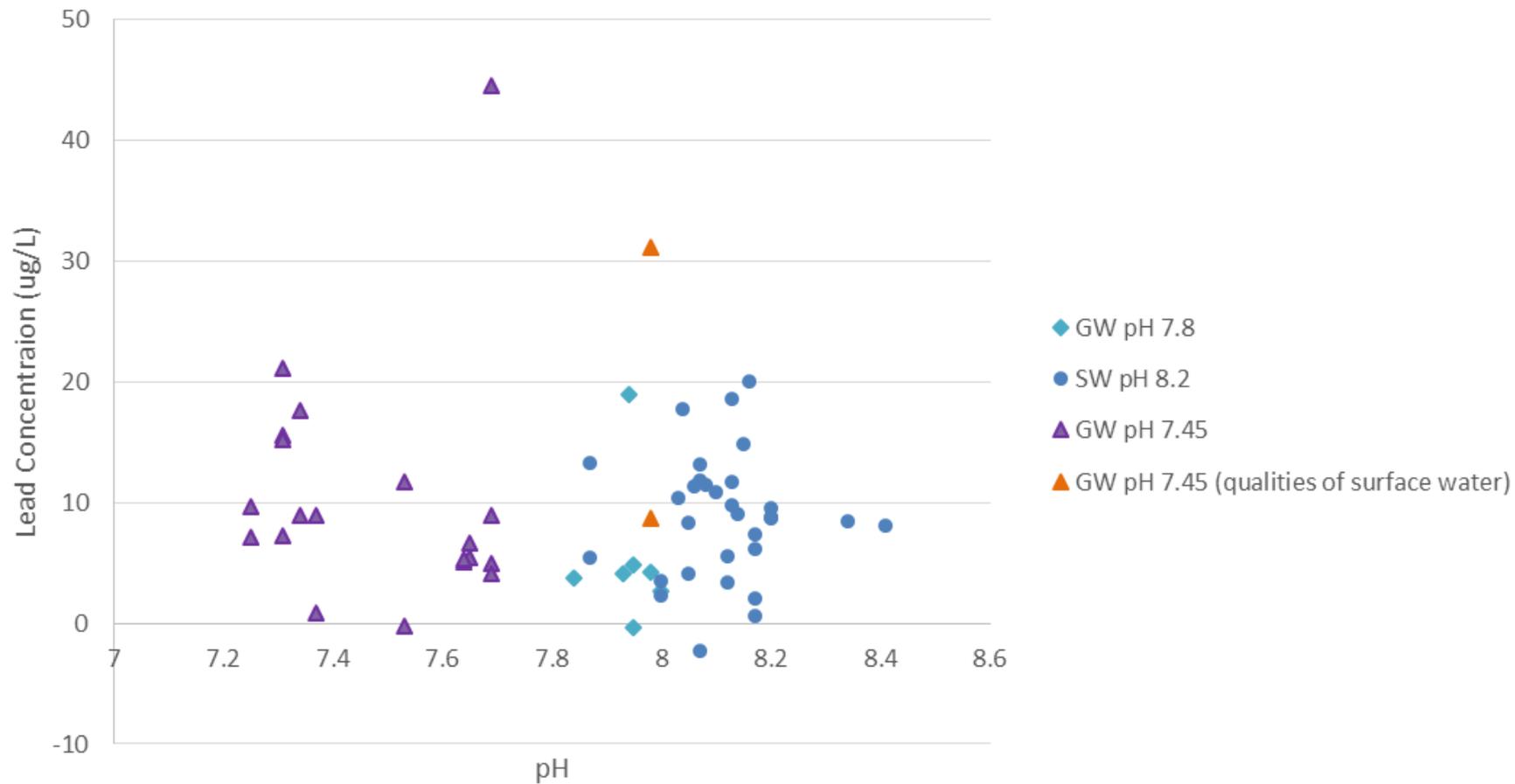
Dissolved Lead v. pH



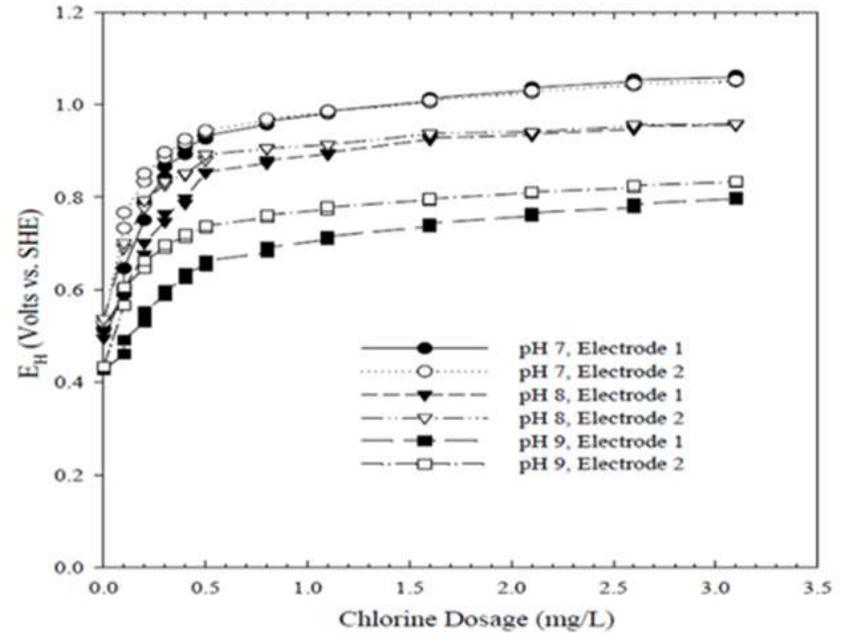
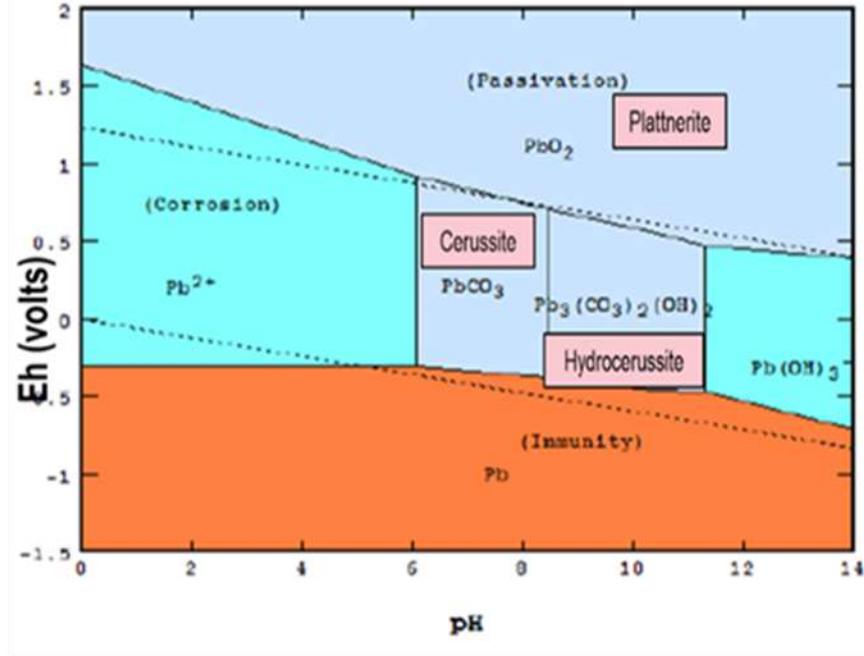
LEAD SOLUBILITY OF GREEN RIVER AND GROUNDWATER



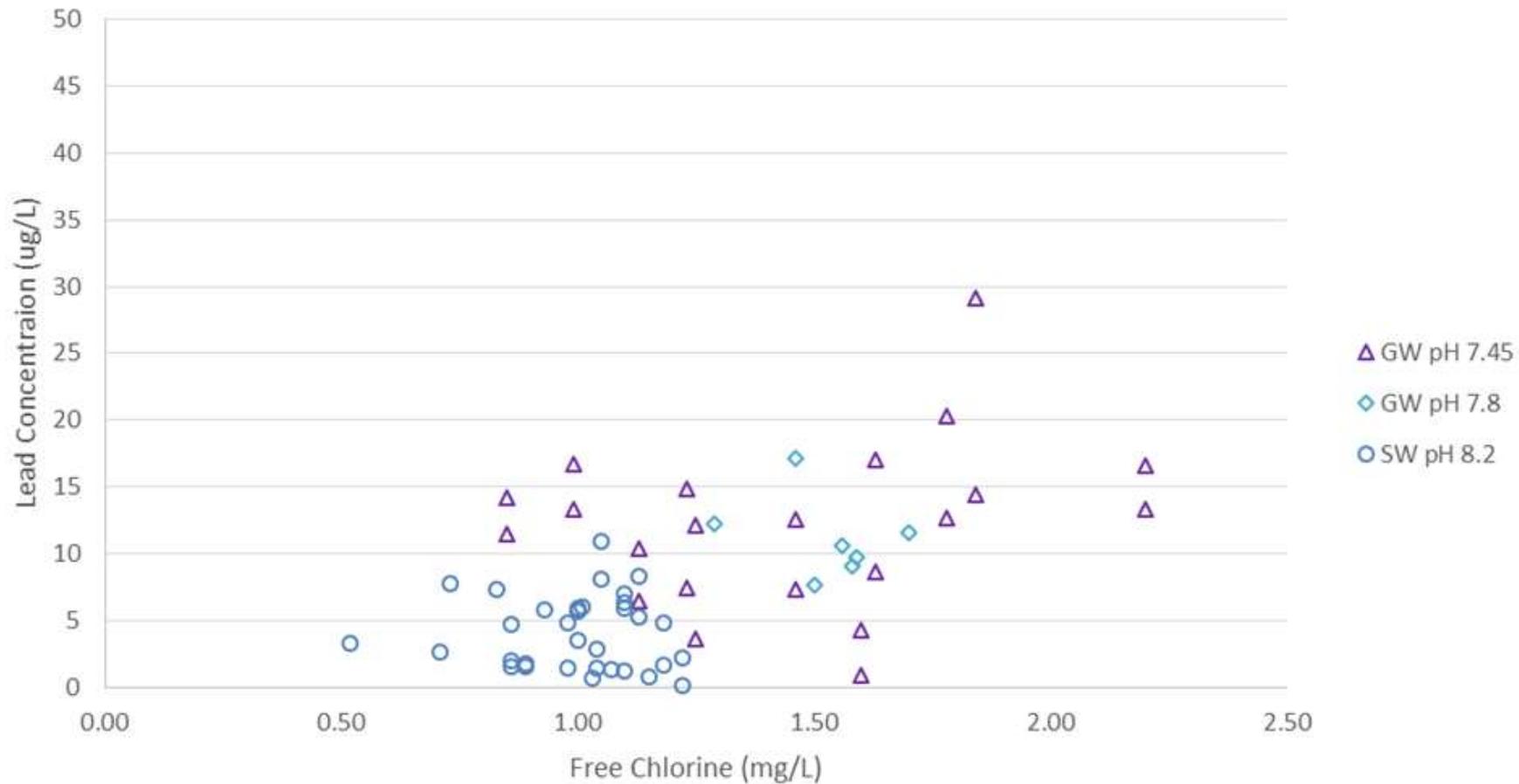
Particulate Lead v. pH

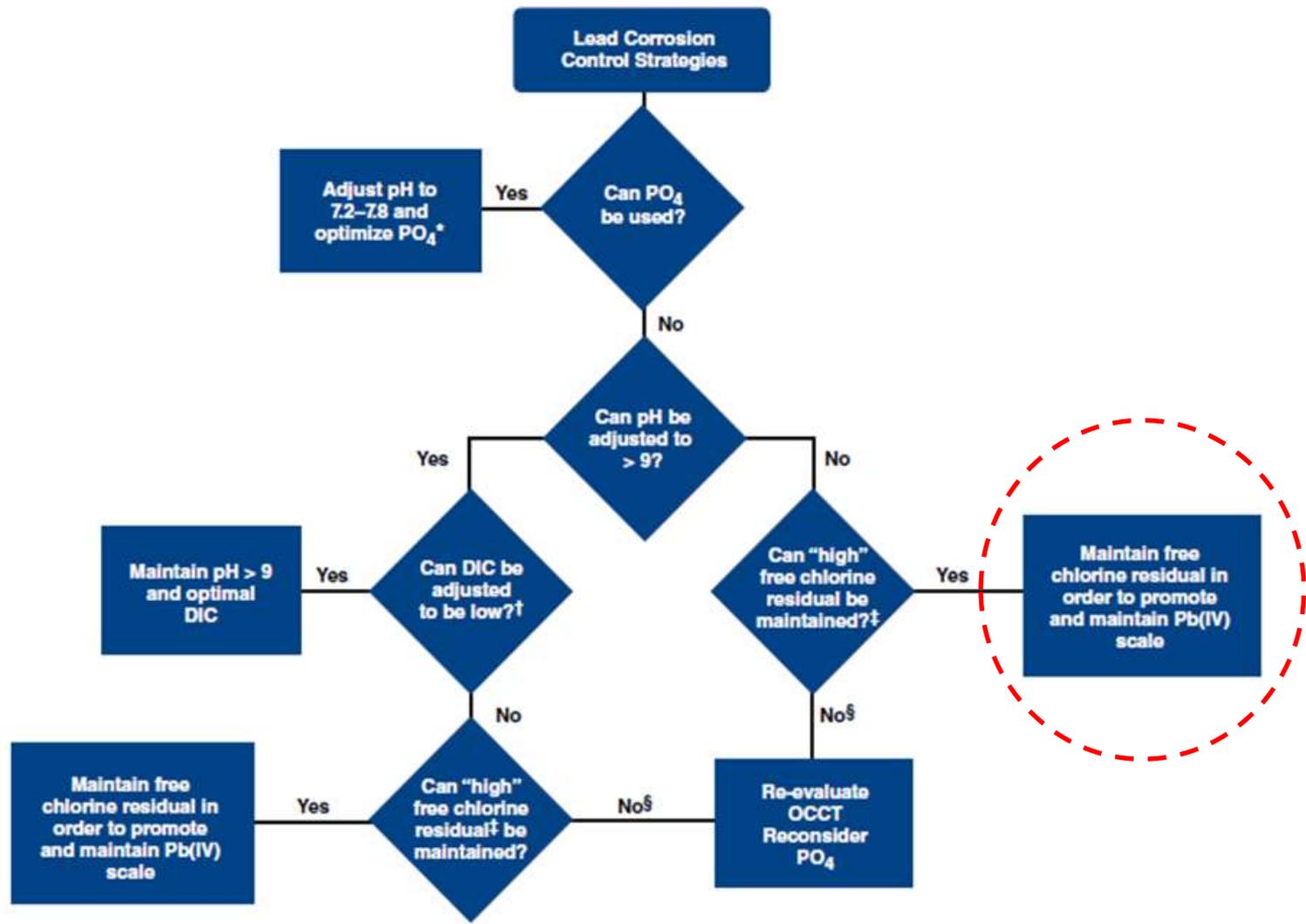


LEAD RELEASE AS A FUNCTION OF ORP



Dissolved Lead v. Free Chlorine







04

CONCLUSIONS AND IMPLEMENTATION

TESTING CONCLUSIONS

- pH has a stronger impact on lead solubility in surface water compared to groundwater.
- Under high oxidation-reduction (chlorinated) conditions, GRFF water can likely form Pb(IV)
 - Pb(IV) is less soluble and more stable than Pb(II) species
- Groundwater lead scale dominated by more soluble, less stable cerussite.
- Maintaining approximately 0.8 mg/L chlorine residual minimizes cerussite formation even with groundwater.

IMPLEMENTATION

- Continued rapid removal of last ~1,000 lead goosenecks in the system.
- Establish the following setpoints, following DOH approval:

| Source | Min. pH Setpoint | Operational pH Setpoint | Min. Alkalinity Setpoint |
|------------------------|------------------|-------------------------|--------------------------|
| Green River | 8.2 | 8.4 +/- 0.2 | 20 |
| South Tacoma Wellfield | 7.4 | 7.6 +/- 0.2 | None |
| Other Groundwater | 7.4 | 7.6 +/- 0.2 | None |

- Increase groundwater chlorine dosage to approximately 1.0 mg/L to increase ORP and minimize cerrusite.

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