Getting the Pipes Clean– A Tale of Two Cities….

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  - Michael Hallett

Presentation Overview

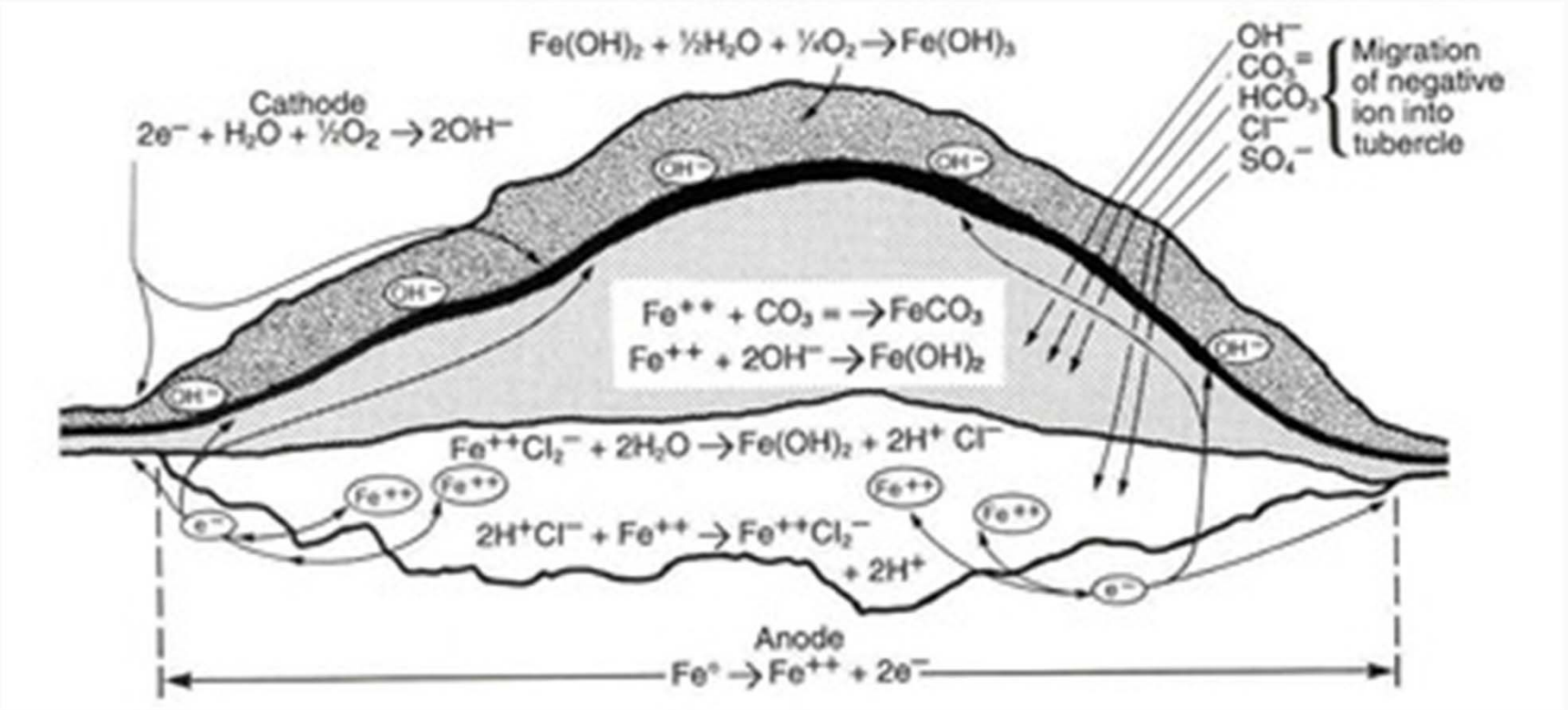
- **More on the City of Longview**
  - Stabilizing and cleaning unlined cast iron pipe
    - Removal of accumulated materials
    - Chemical stabilization processes
- **City of Tigard**
  - Cleaning cement-lined pipes
  - Findings from recent pilot UDF study
- **Conclusions**

More on the City of Longview…

To Clean or Not to Clean…

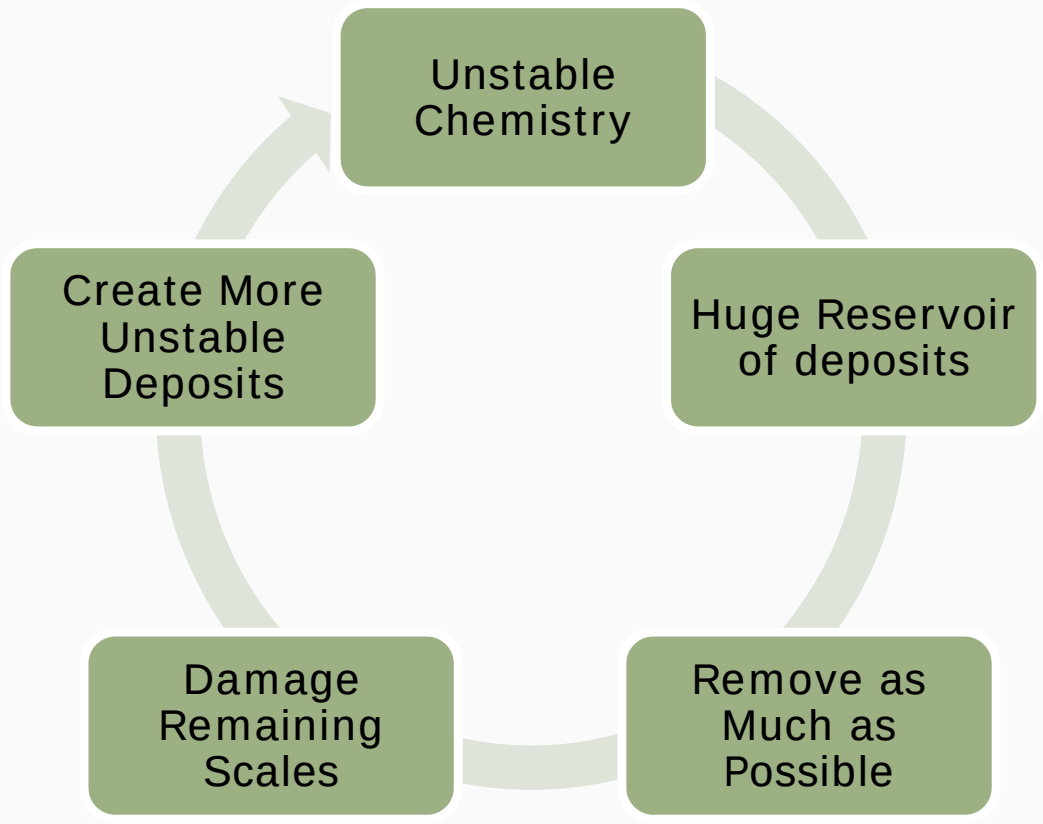
- **Was flushing helping or hurting?**
  - Needed to clean up destabilized solids
  - But avoid creating more…..
    - Still had unstable chemistry
    - Don’t want to knock off or damage existing tubercles

The Anatomy of a Tubercle

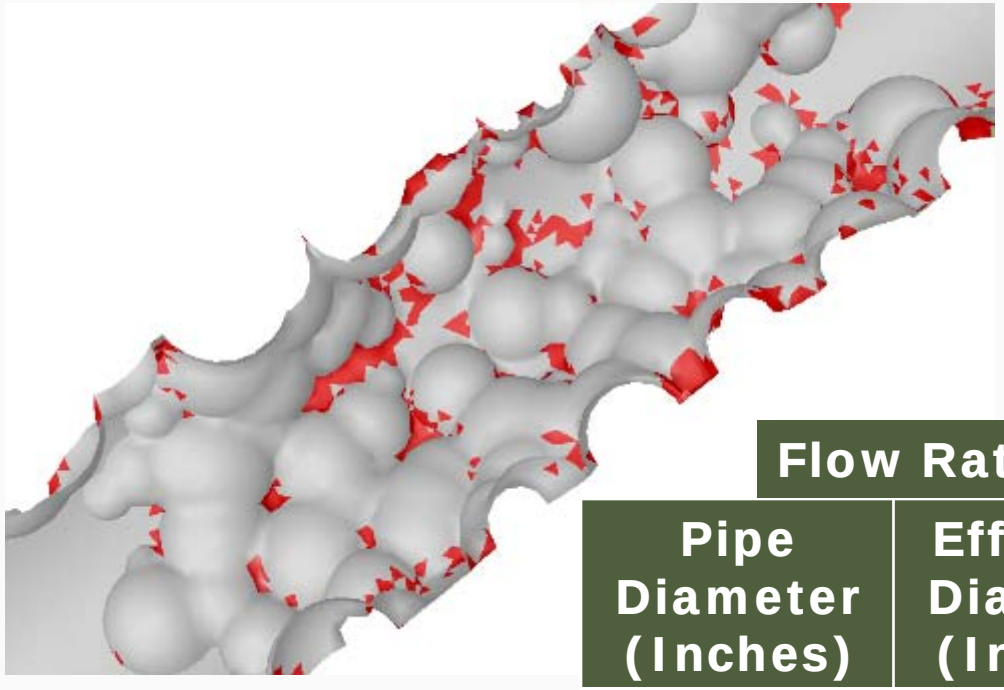


Source: MiC Europe, The Netherlands

The Doom Loop of Distribution Systems...



What Velocity Are Those Tubercles Experiencing?



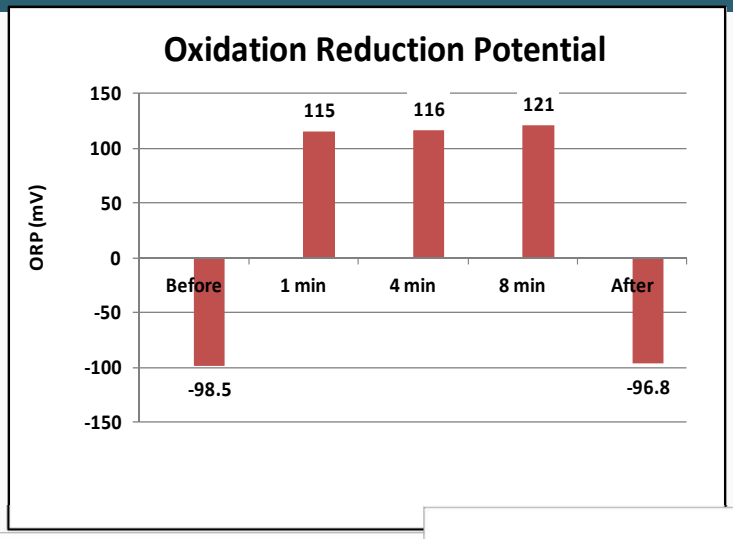
Flow Rate = 500 gpm

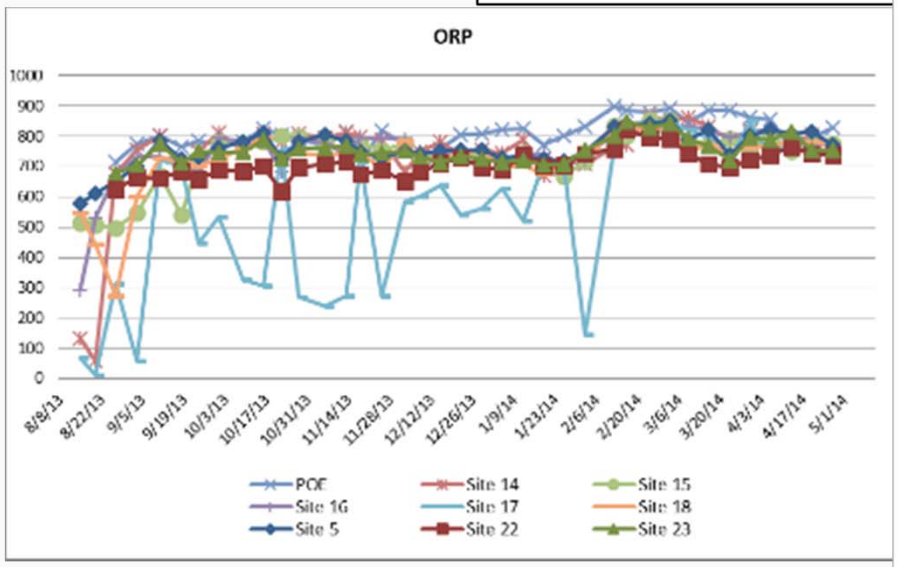
Pipe Diameter (Inches)	Effective Diameter (Inches)	Velocity (fps)
6	6	5.7
6	5.5	6.7
6	5	8.2
6	4.5	10.1
6	4	12.8

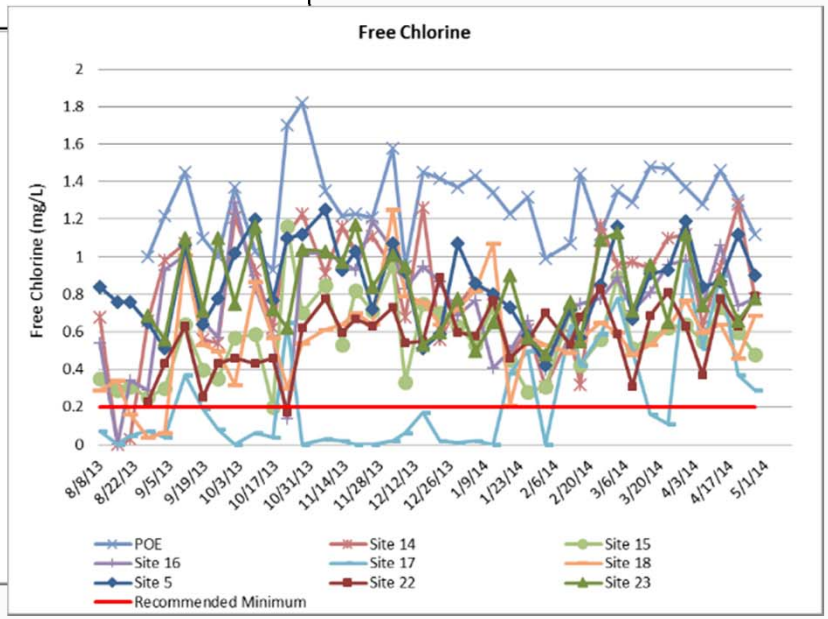
Back to Longview's Dilemma

- **Unstable chemistry**
- **Unstable pipe scales**
- **High velocity UDF is knocking tubercles off**
- **So what about ice pigging???**
  - Removed a lot of stuff, but did not see long-lasting improvement
  - Why not?

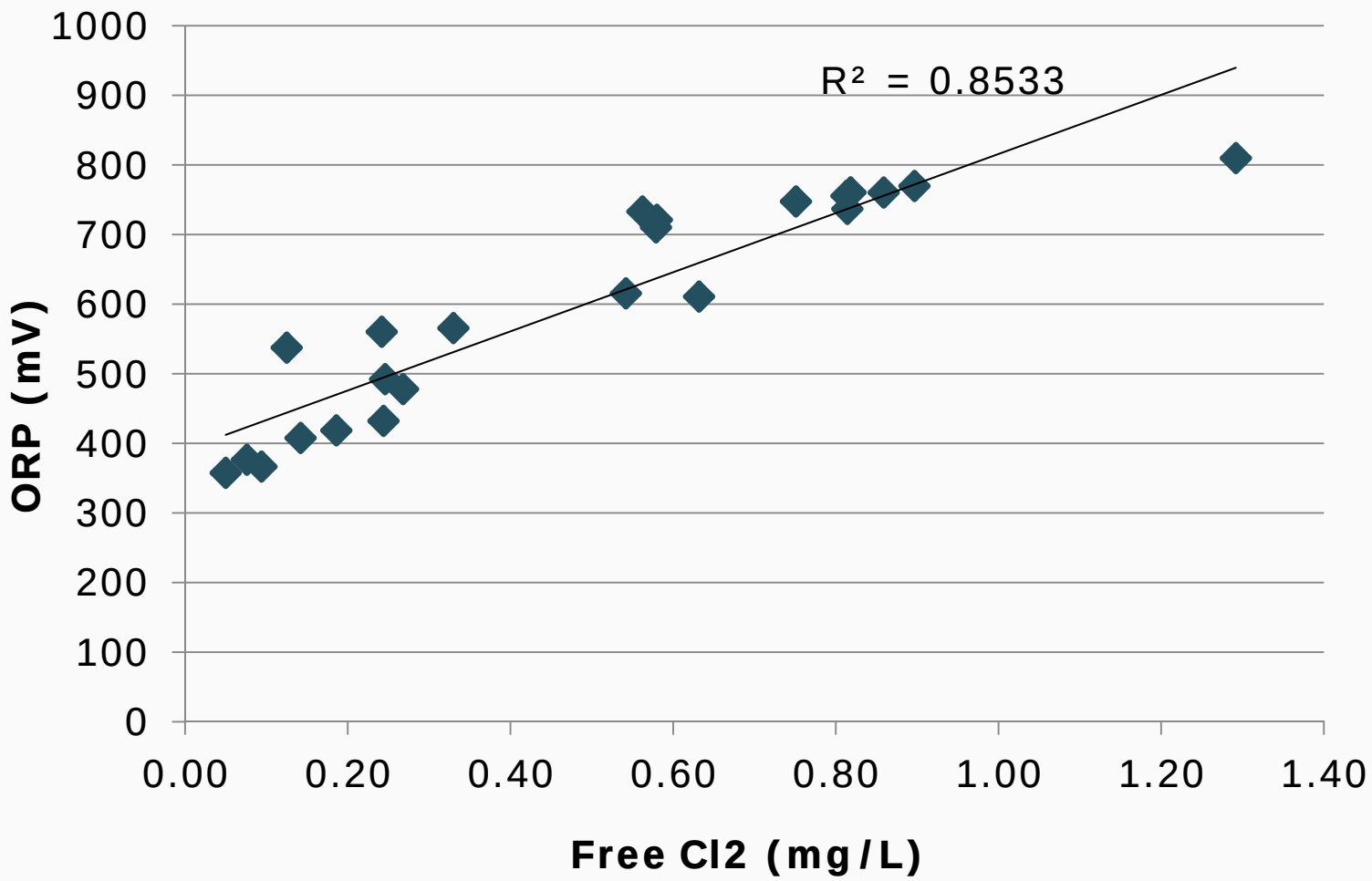
Took Months for Chemistry to Stabilize



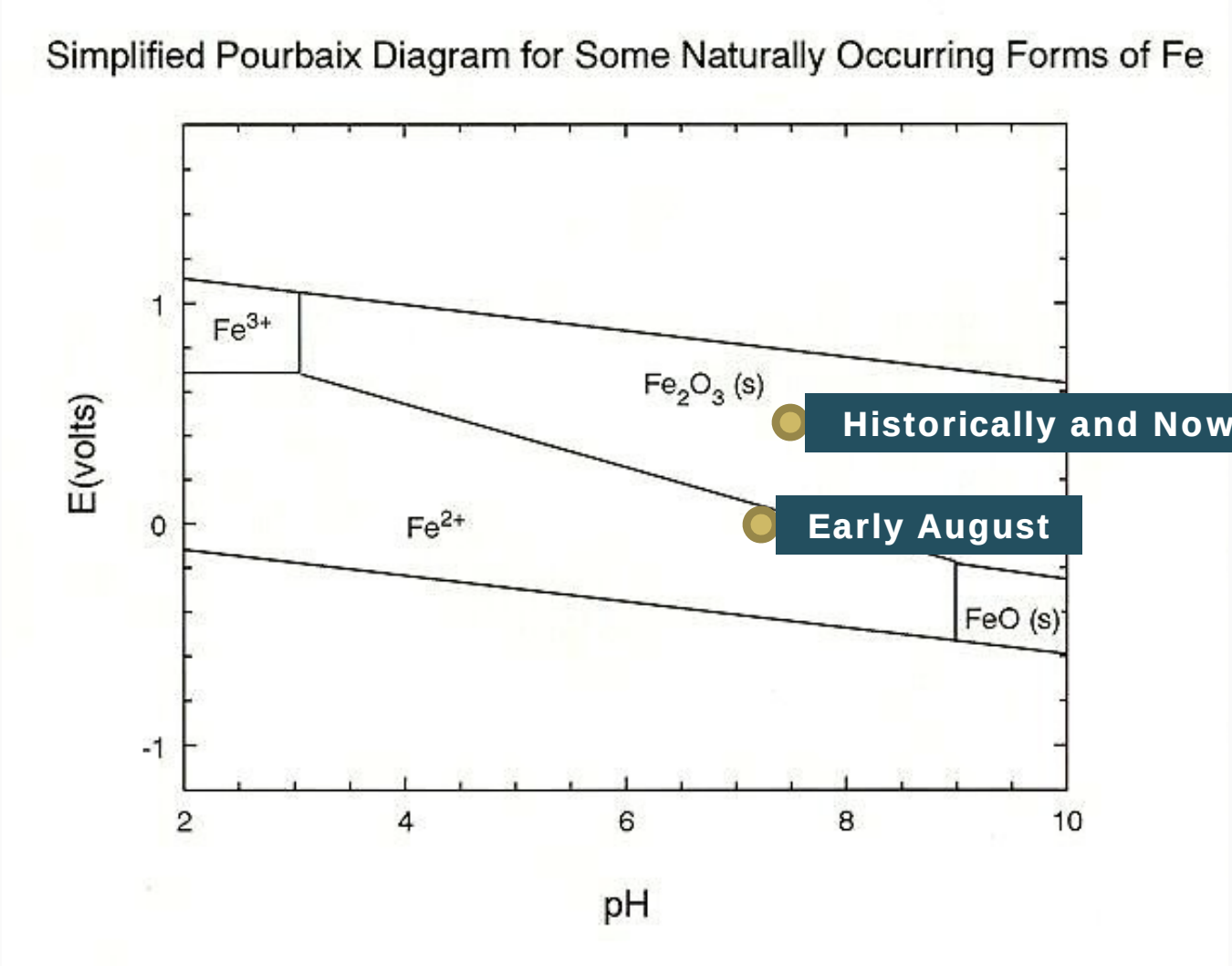




Chlorine vs. ORP

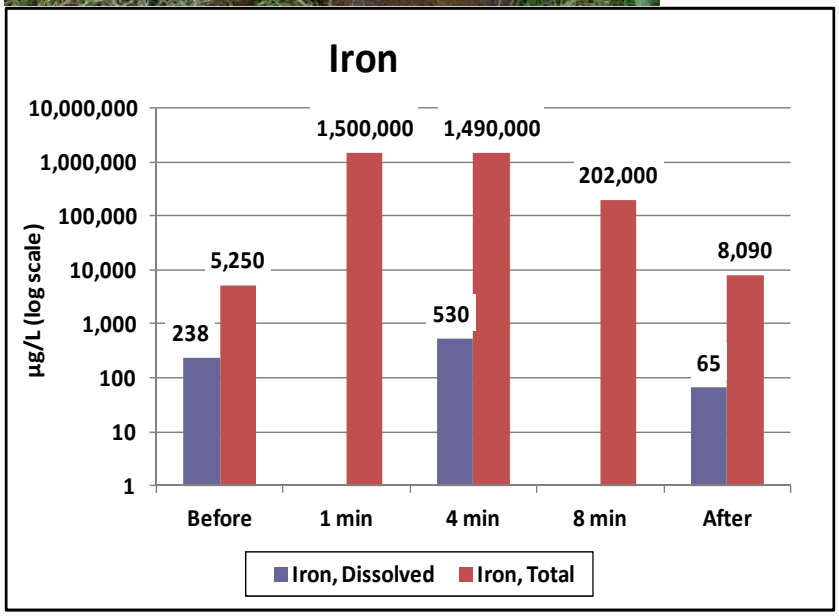


Effect of ORP Plunge



Profiling the Ice Pig

Source: Opflow, April 2014



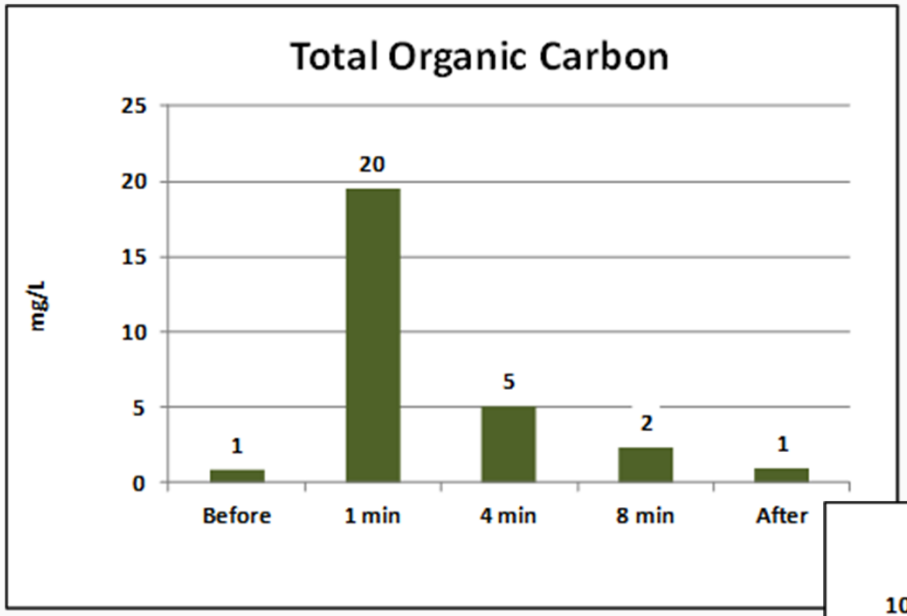
Source: Confluence Engineering Group, LLC

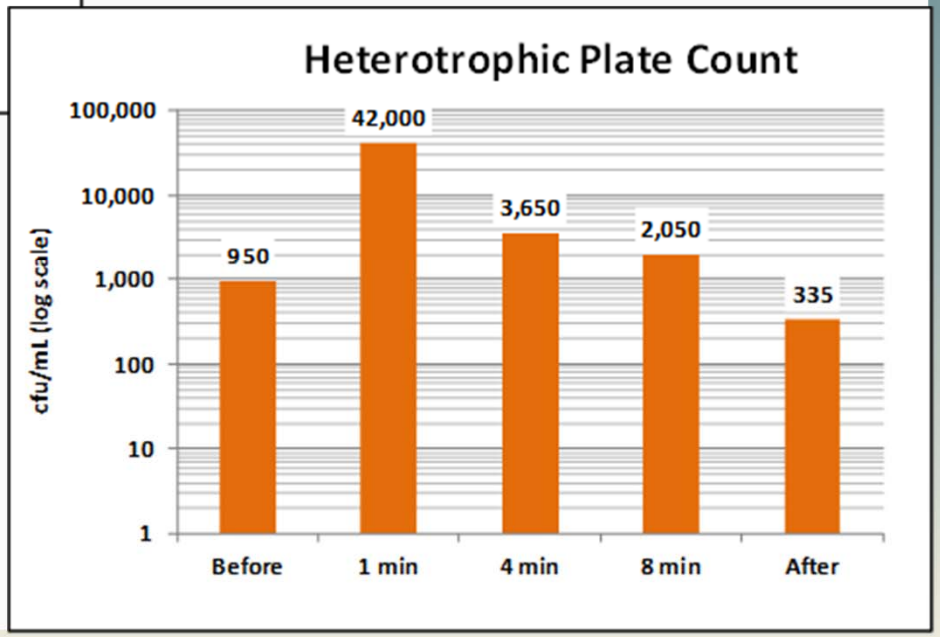
Mass of Metals Removed by Ice Pigging

Metal	Mass Removed				Percent
	(lb)	(lb/mile)	(g)	(g/mile)	(%)(a)
Iron	22.8	60.2	10,344	27,309	34
Aluminum	1.07	2.83	486.1	1,283	1.6
Manganese	0.4	1.1	192.2	507.3	0.6
Zinc	0.152	0.401	68.9	182	0.2
Copper	0.03	0.0845	14.5	38.3	0.04
Barium	0.0172	0.0454	7.8	20.6	0.03
Lead	0.01	0.026	4.5	11.9	0.01
Arsenic	0.003	0.009	1.5	3.9	0.00
Total	24.5	64.7	11,120	29,356	36.5

Source: Confluence Engineering Group, LLC

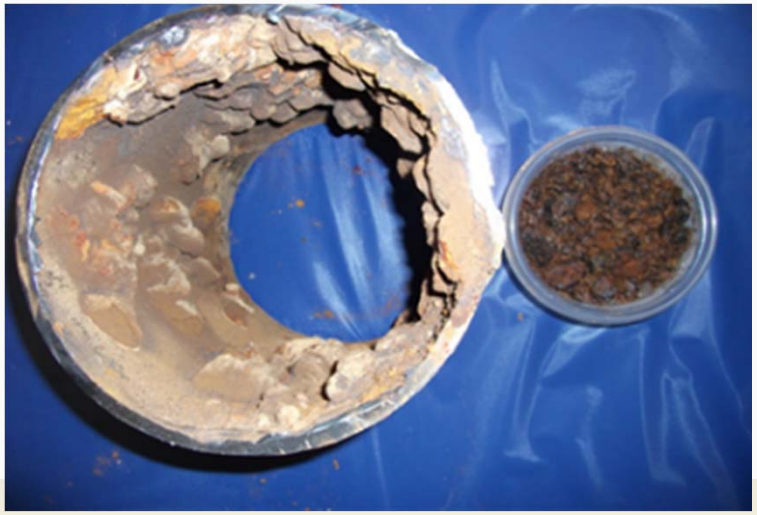
Organics and Bacteria Removed by Ice Pigging



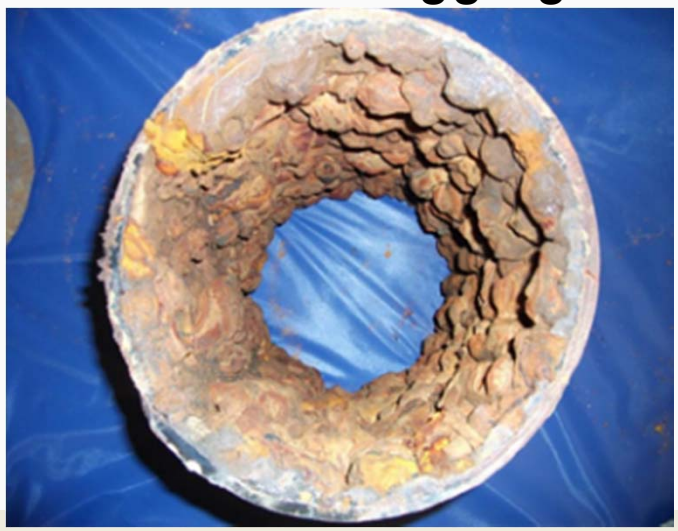


Tubercles Before and After Ice Pigging

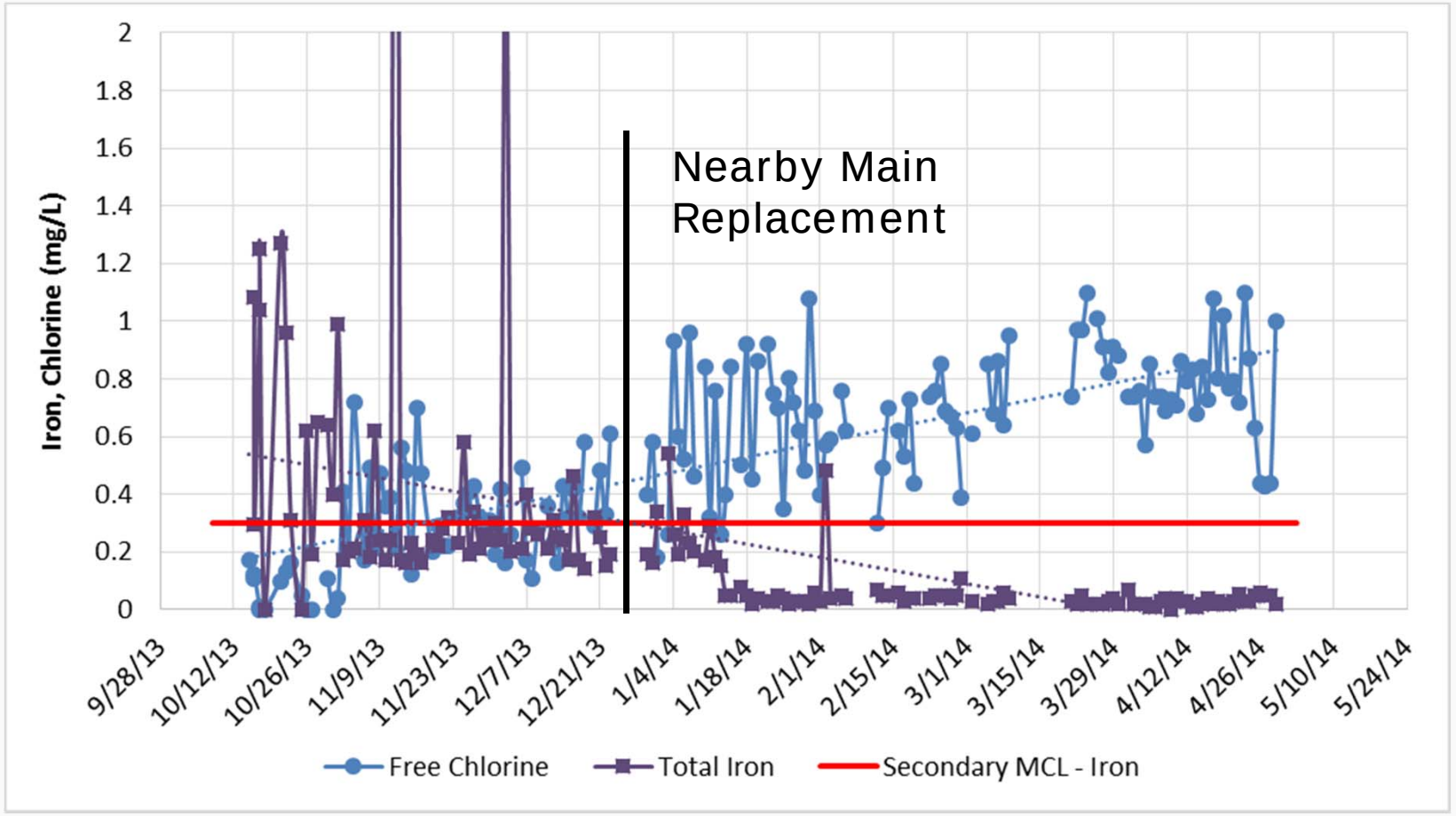
Before Ice Pigging



After Ice Pigging

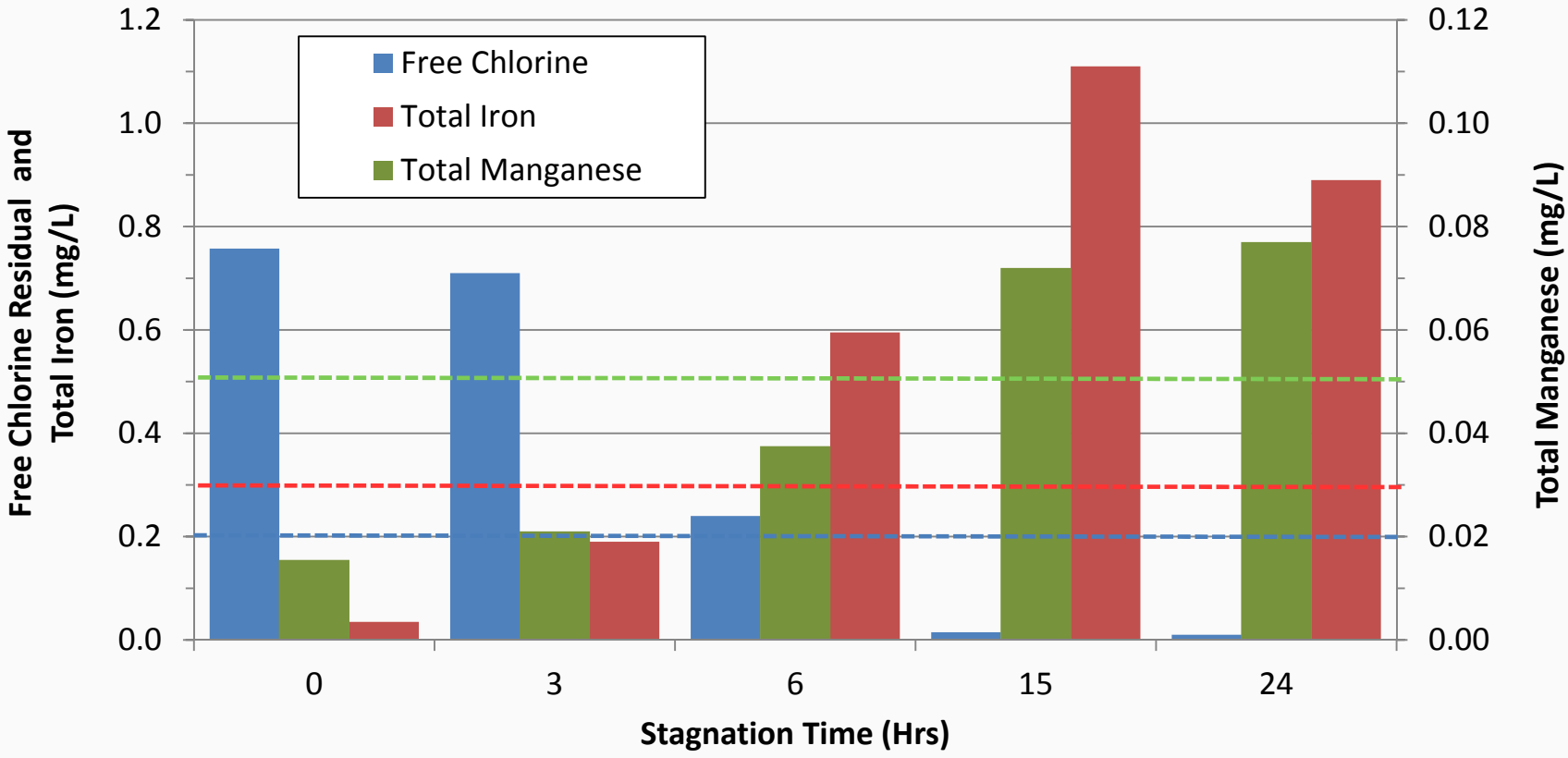


Importance of Positive ORP for Preventing Iron Release

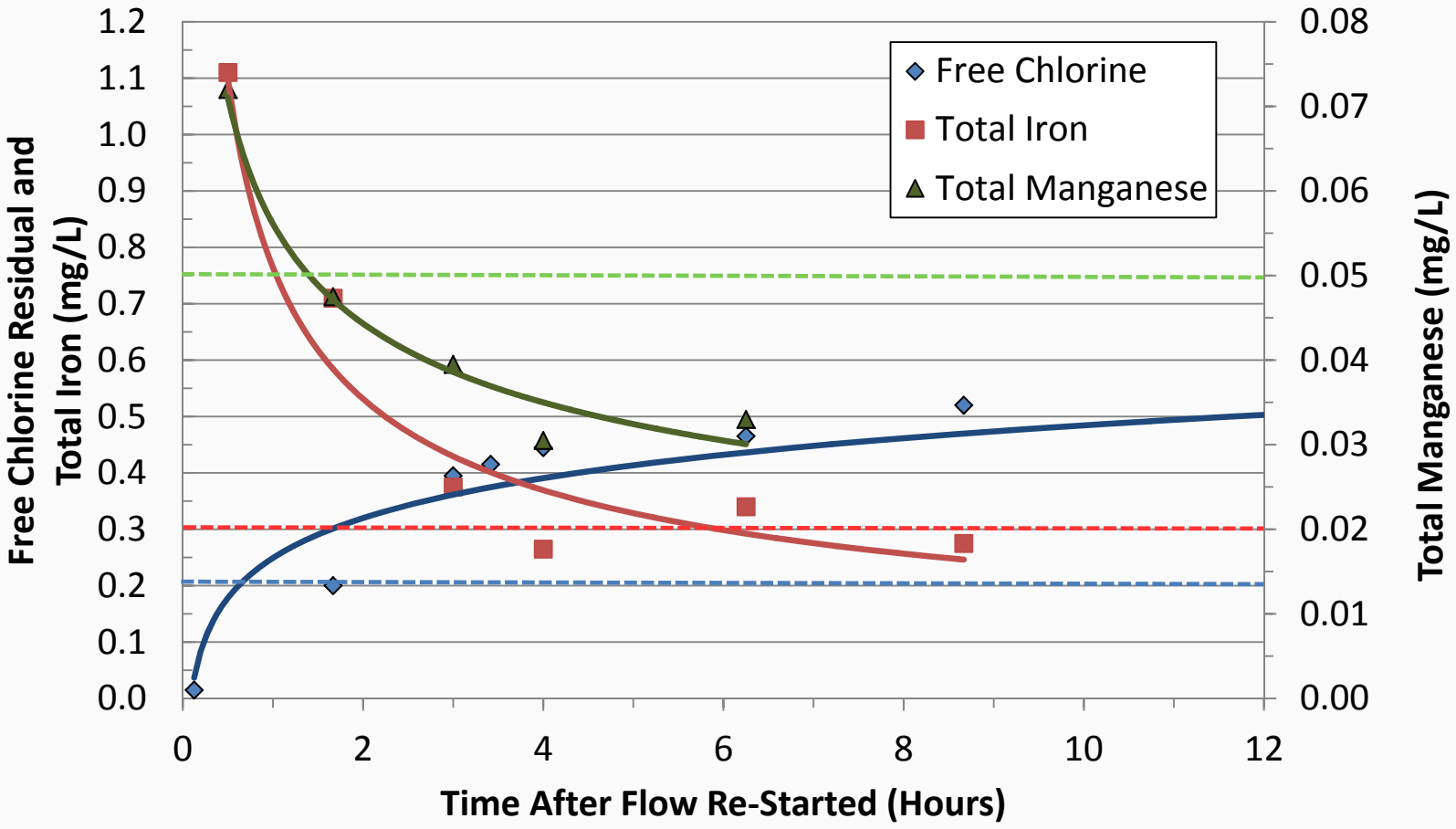


On-Going Study using Pipe Rigs

Water Quality Degradation with Increasing Stagnation Time



Water Quality Recovery following 15-hr Stagnation



Take Home Messages for Cleaning Unlined Cast Iron Pipe…

- **Avoid velocities that are too high**
  - Consider effective pipe diameter
  - Do not knock off tubercles
- **No main cleaning strategy will prevent on-going or future water quality problems unless:**
  - Water chemistry is stable
    - Positive ORP
    - Good chlorine residual
    - Stable pH
  - You've removed the tubercles and relined the pipe

On to the City of Tigard...

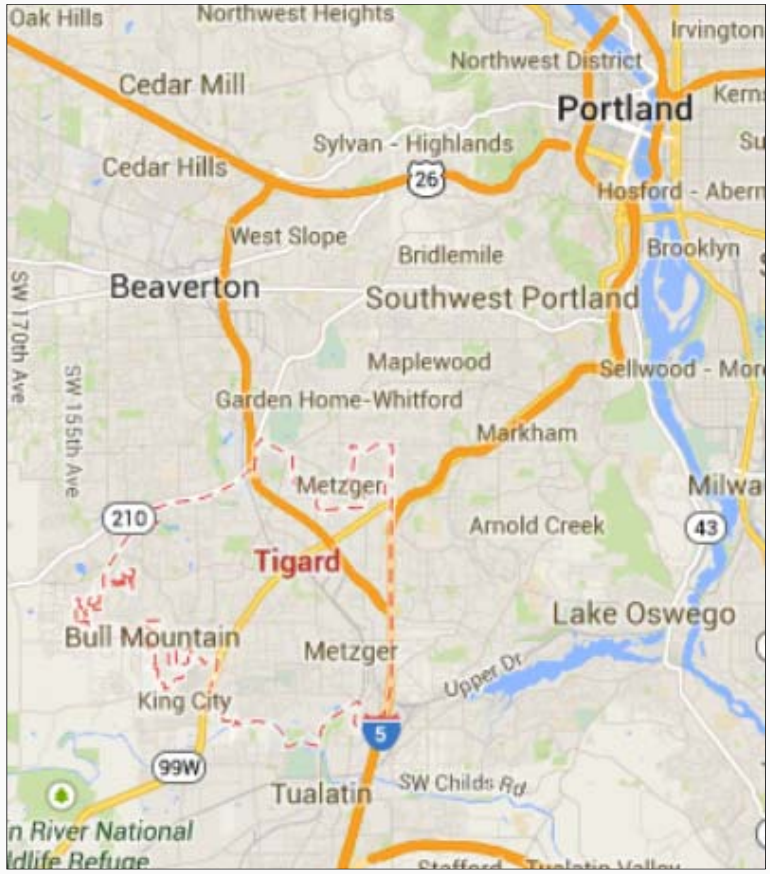
Tigard Water System Overview

Service Area

- Cities of Tigard, Durham, & King City, plus portion of unincorporated Washington County
- Service population ~ 60,000
- Avg Day Demand ~ 6.5 MGD

Distribution System

- Five major pressure zones
- 250 miles of water mains
  - 4 to 36-inch diameter
  - 225 miles are ≤ 12-inch
  - All pipe is cement-lined



Water Supply … Big Changes are Coming

	Historical and Current	Transition in 2015/2016
Primary Supply	• Purchased from Portland	• New Lake Oswego-Tigard Joint Water Supply
Treatment/ Chemistry	• Unfiltered Bull Run water • Chloramine Residual	• Ozonated, filtered (BAF) Clackamas River water • Free Chlorine Residual
Introduced to Tigard System	• To 470 zone via Portland supply line	• To 410/470 zones via the LO system and new BPS

Preventative mains cleaning was identified as a high-priority need based on risk factors for accum and release of legacy deposits

Historical Flushing Practices

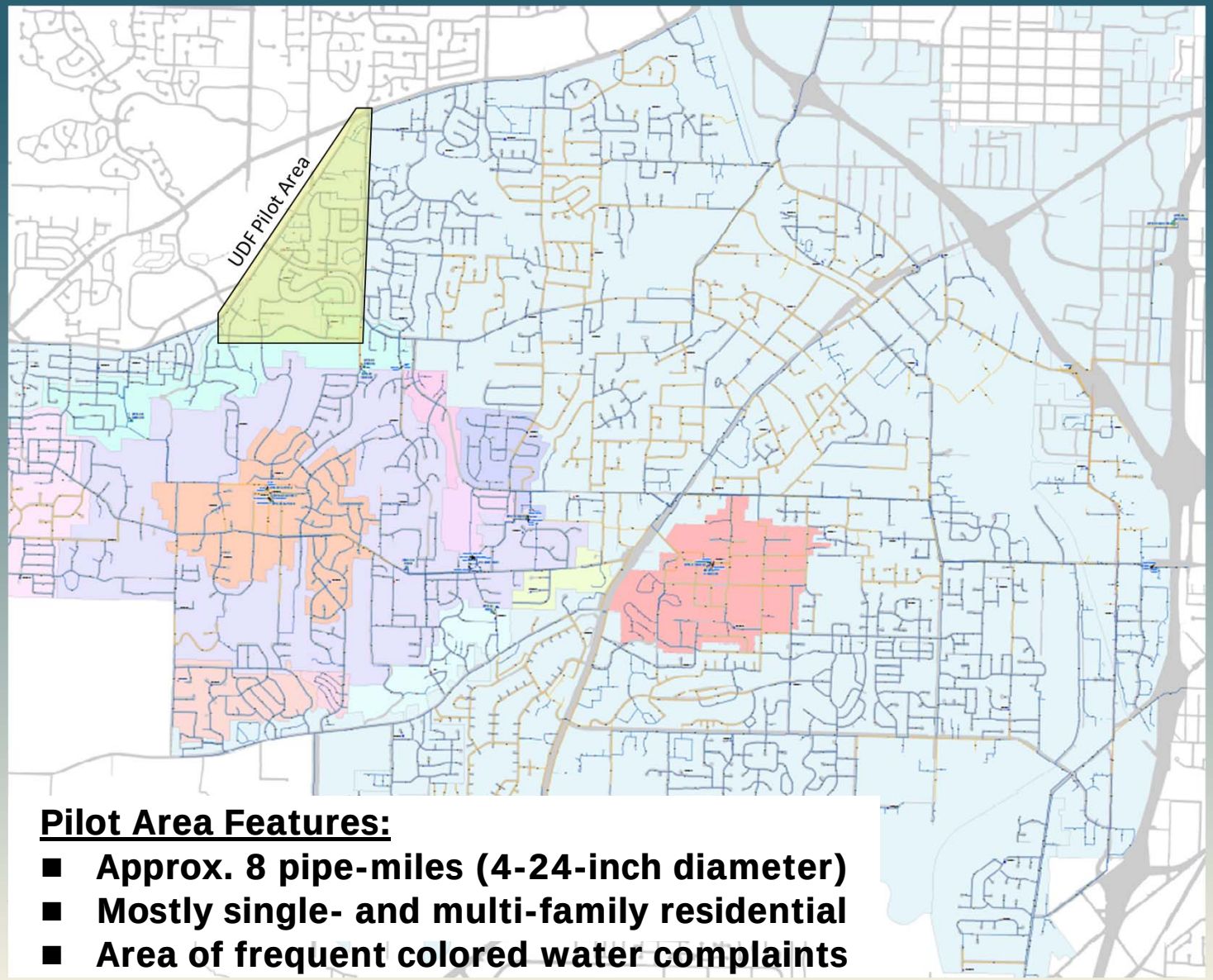
- **No unidirectional flushing or mains cleaning program**
- **Conventional spot flushing used reactively as a quick-fix to water quality issues**
  - Customer WQ complaints
  - Low disinfectant residuals
- **Goal has been strictly bulk water turnover**
  - Low flow (< 2 fps) used to avoid disturbing deposits…higher flows have created issues
  - Highlights the significant amount & sensitive nature of legacy deposits

Accumulated particles in Tigard's DS are fine, light, loose, and impart a rust-colored appearance.

Pilot Flushing Program

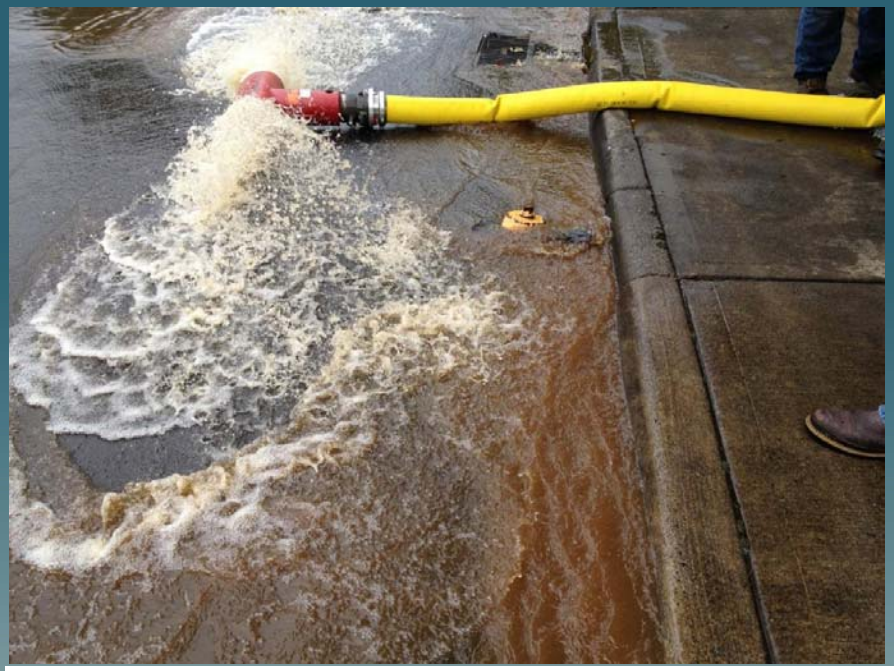
- **UDF recommended for evaluation**
- **Pilot Program conducted in 2013**
  - Program Goals:
    - UDF program startup and protocols
    - Crew training on SOPs and techniques
    - Resource estimation for full-scale program
  - Technical Goals:
    - Assess flushing effectiveness
    - Identify optimal velocity and duration
    - Evaluate large-diameter mains (≥ 12-in)

Pilot Flushing Area



Pilot Area Features:

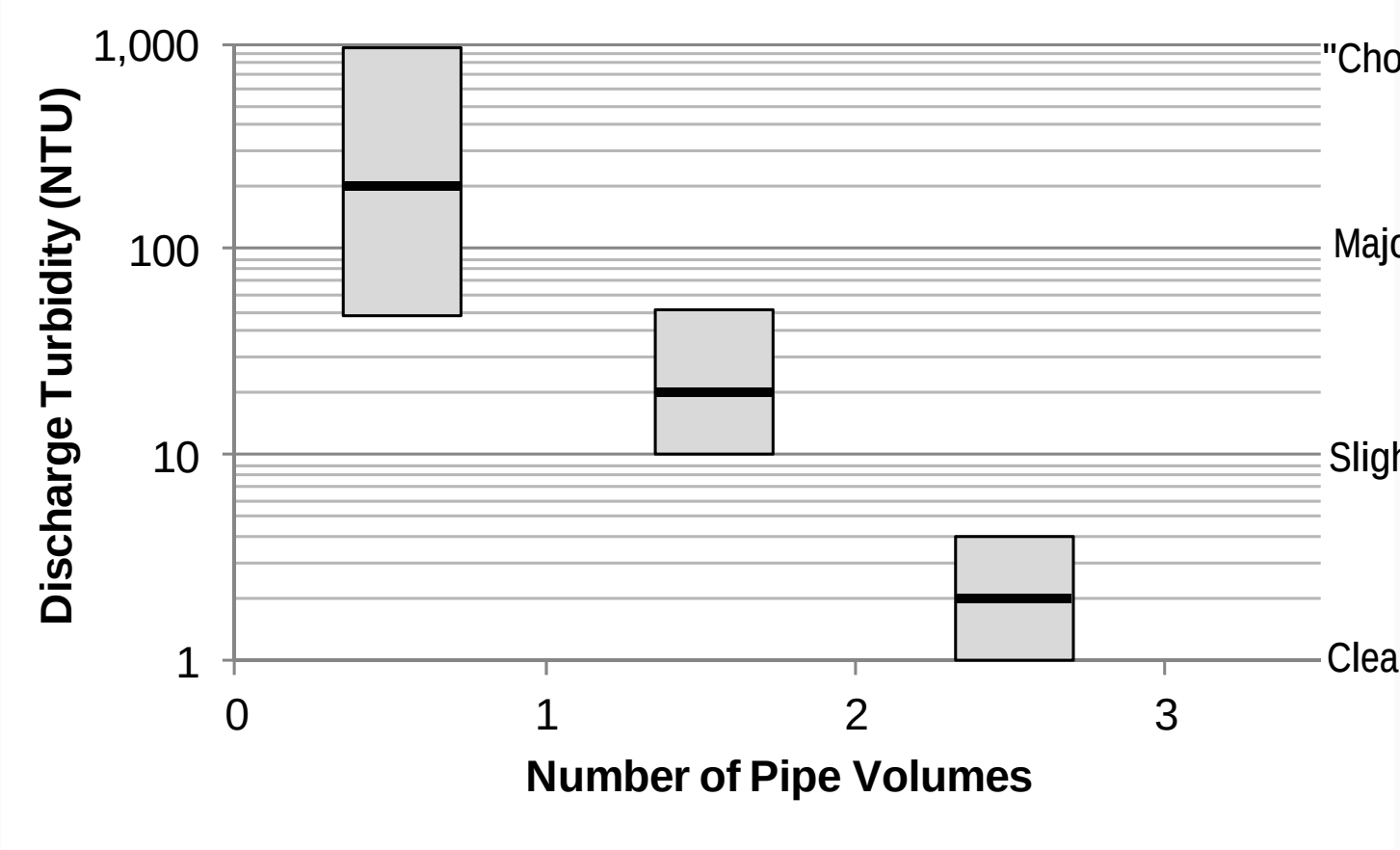
- Approx. 8 pipe-miles (4-24-inch diameter)
- Mostly single- and multi-family residential
- Area of frequent colored water complaints



Color associated with 200 NTU flushing discharge, the average turbidity seen during the first pipe volume of pilot area loops.

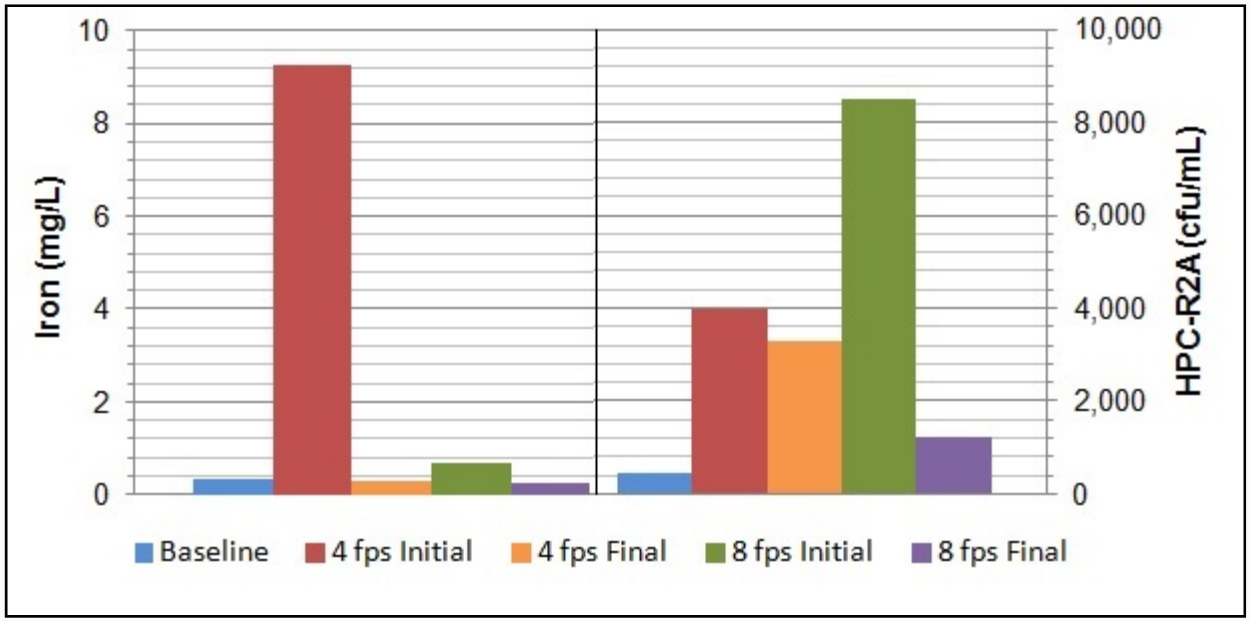
Portable street signs with flyers were set up prior to field work. They were found to be an effective communication tool with the public and customers.

Sediment Removal Trends



For flushing velocities ≥ 4 fps
Velocities as low as 1.5 fps caused long, slow, turbidity "bleeding" process

Contaminant-Specific Velocity Performance



Cannot rely solely on visual appearance to determine optimal flushing velocity.

For Tigard, increasing the flushing velocity up to 8 fps improved biofilm scouring.

Conclusions

- **Water supply and treatment changes can cause adverse, unanticipated water quality consequences within the DS**
- **Proactive mains cleaning can minimize impacts/risks by removing accumulated deposits**
- **Won't see lasting results on unlined cast iron if chemistry is unstable or if damaged pipe scale during flushing**
- **One size does not fit all when it comes to flushing!**
  - Pipe material and condition
  - Velocity
- **Consequences of non-optimal velocities**
  - Too Low = Ineffective Cleaning
  - Too High = WQ and Pipe Risks, Wasted Water

Questions?

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