



# **WATER QUALITY UPDATE**

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## **Outline**

- ▶ **Emergency Waterline Replacement**
- ▶ **Customer Outreach**
- ▶ **Distribution System Water Quality Progress Report**
- ▶ **Pipe Rigs**
- ▶ **Time of Travel Study**
- ▶ **Phosphates**
- ▶ **White Spotting Investigation**
- ▶ **Recommendations**

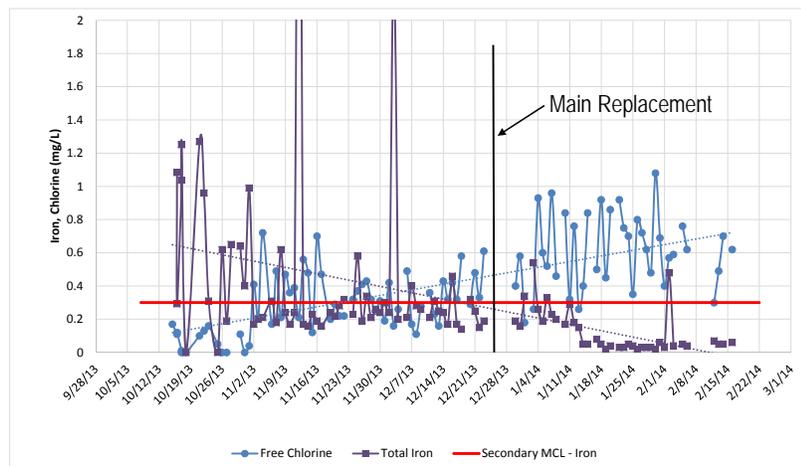


## Progress Report – Emergency Water Mains

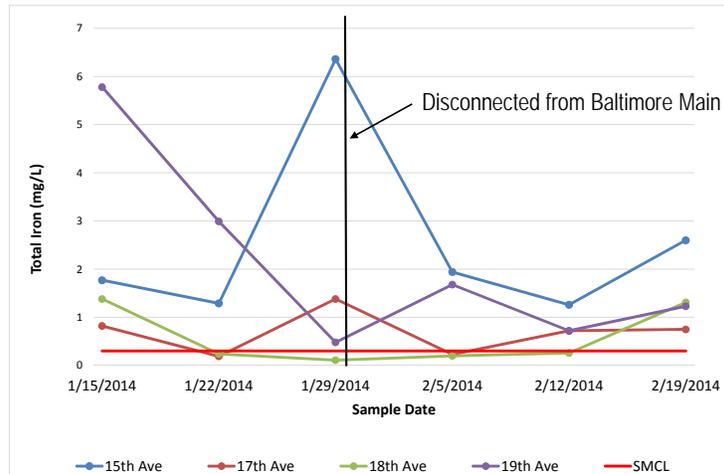
- ▶ New mains and all customer services are complete
- ▶ Existing alley mains disconnected from Baltimore main January 30<sup>th</sup>
- ▶ Baltimore main abandoned between 15<sup>th</sup> and 20<sup>th</sup> Avenues
- ▶ Hydrant installation is underway; minimal disturbance expected
- ▶ Pavement repairs 50% complete on Beech; restoration work continues
- ▶ Final completion delayed to late March due to inclement weather
- ▶ Improved water quality and chlorine residual in new mains



## Alley Main Between 16<sup>th</sup> and 17<sup>th</sup> Avenues



## Baltimore Area Water Quality (600 Block)



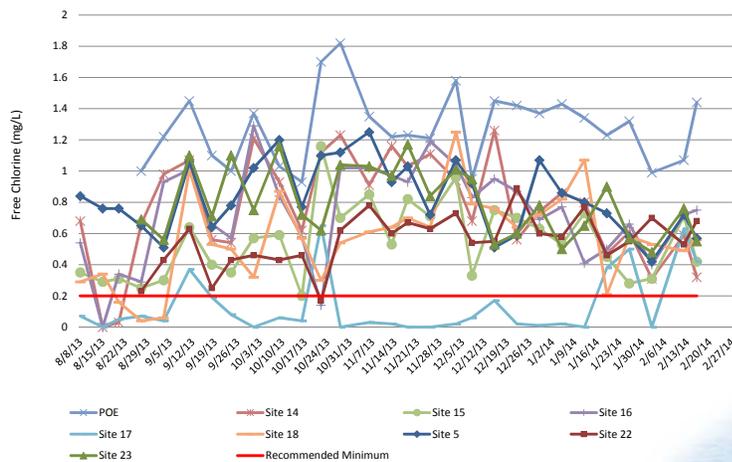
## Progress Report – Customer Outreach

- ▶ Ongoing bottled water delivery
  - Discontinued Dec. 31, 2013 for customers served by new alley main
- ▶ Customer complaints down to 5 - 6 per week
- ▶ Rate reductions approved for 372 customers
  - 6-month reductions expire April, 2014
  - Original 2-month reductions expired Feb. 9, 2014
  - 3 new rate reductions approved since Jan. 23, 2014
- ▶ YMCA shower privileges – Unaware of any use over last 2 months
- ▶ News from the Well updates published regularly

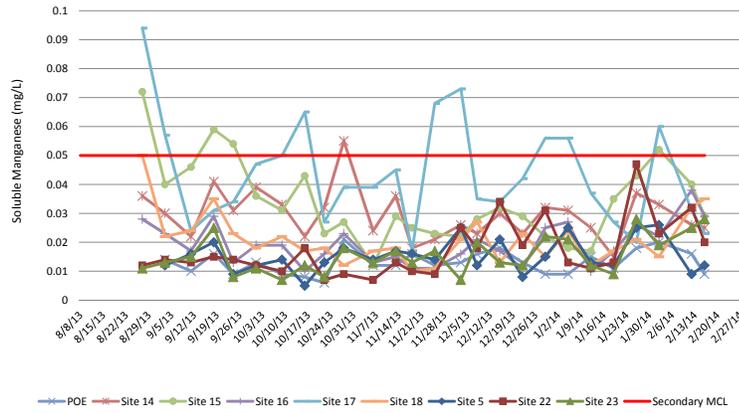
## Progress Report - Distribution System Water Quality

- ▶ Ongoing distribution system sampling at 9 sites
  - Acceptable chlorine level at all areas except Site 17 – but improving in this area
  - Oxidation Reduction Potential (ORP) stabilized at all areas except Site 17 – but improving in this area
  - Mn level routinely at or below SMCL at all areas
  - Recent trends show fluctuations in iron and manganese, but this is due to lower chlorine and absence of flushing due to weather concerns
  - Test results indicate the distribution system can be stabilized

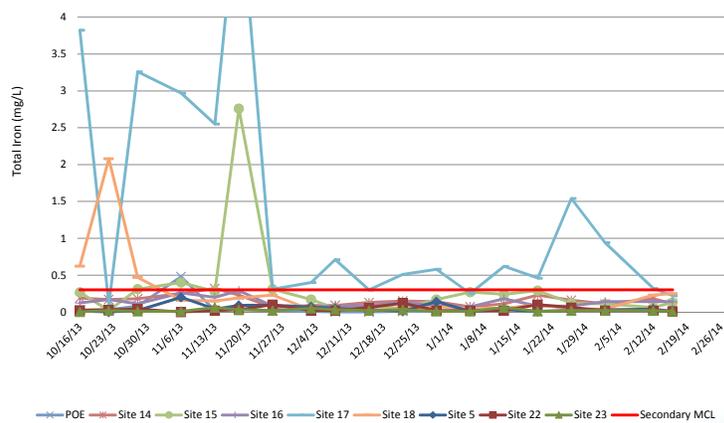
## Chlorine Residual Trends



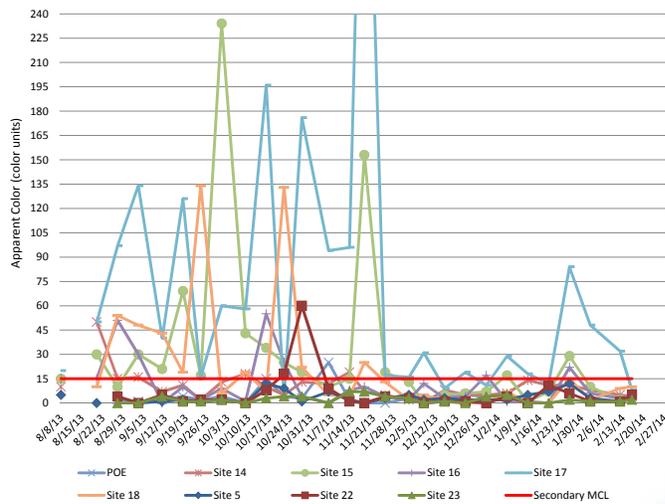
## Soluble Manganese Trends



## Total Iron Trends



## Apparent Color Trends



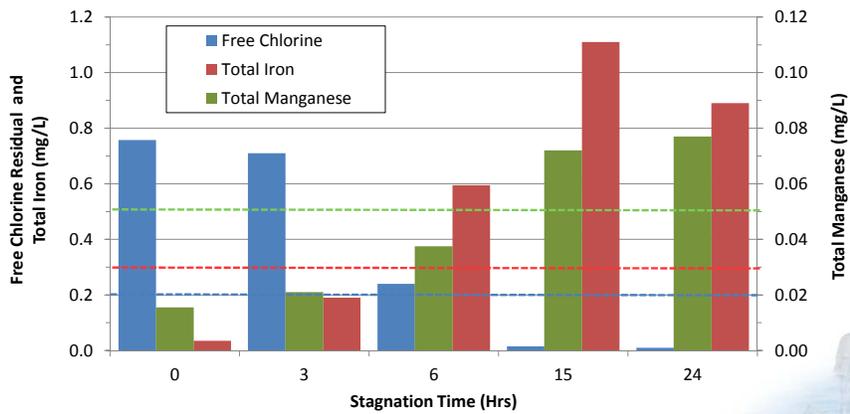
## Progress Report - Pipe Rig Studies

- ▶ **What is a pipe rig?**
  - **Small-scale distribution system used to study and understand the full-scale system**
  - **Assembled from existing pipes recently removed from the system**
    - Alley between 16<sup>th</sup> and 17<sup>th</sup>
    - Ocean Beach Hwy
  - **Water flows through the pipes, like in the real system**
  - **Different flow rates and stagnation times can be studied**
  - **Alternate chemical treatments could be evaluated**

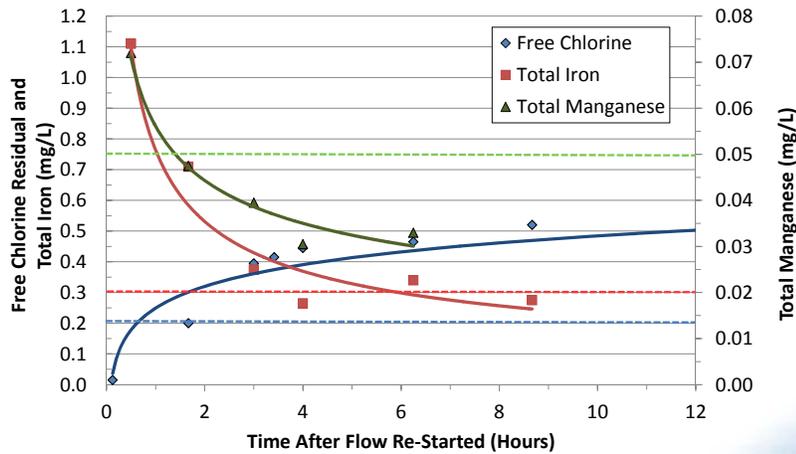
## Pipe Rigs



## Water Quality Degradation with Increasing Stagnation Time



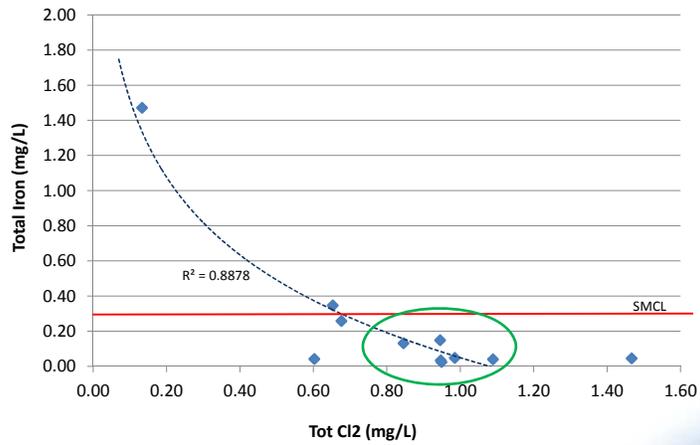
## Water Quality Recovery following 15-hr Stagnation



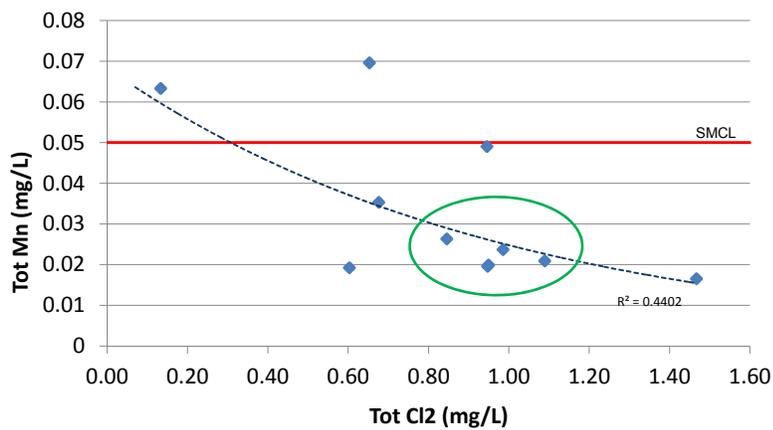
## Pipe Rig Studies - Findings

- ▶ Chlorine residual (and ORP) dropped significantly, especially with more than 6-hours of stagnation
- ▶ High levels of iron and manganese were observed, due to loss of chlorine residual and ORP
- ▶ Water quality rapidly improved along with chlorine residual and ORP when freshly treated water flows through the pipe rig
- ▶ Results can be used to develop proactive guidelines for maintaining water quality throughout distribution system
  - Iron and manganese are controlled when chlorine  $\geq 0.6$  mg/L

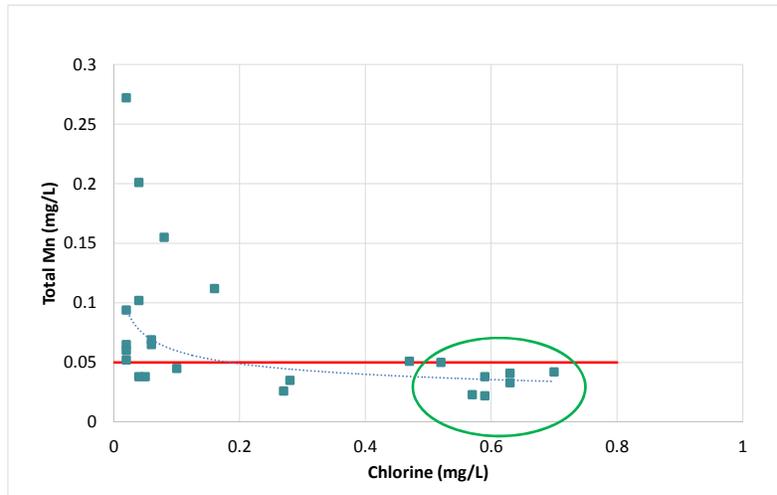
### Average Chlorine vs. Iron for On-going Distribution System Sites



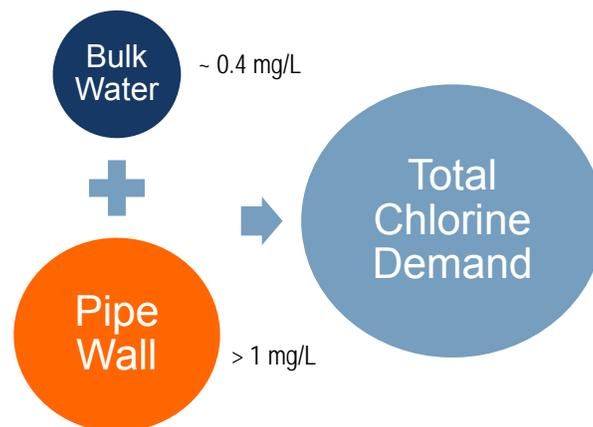
### Average Chlorine vs. Manganese for On-going Distribution System Sites



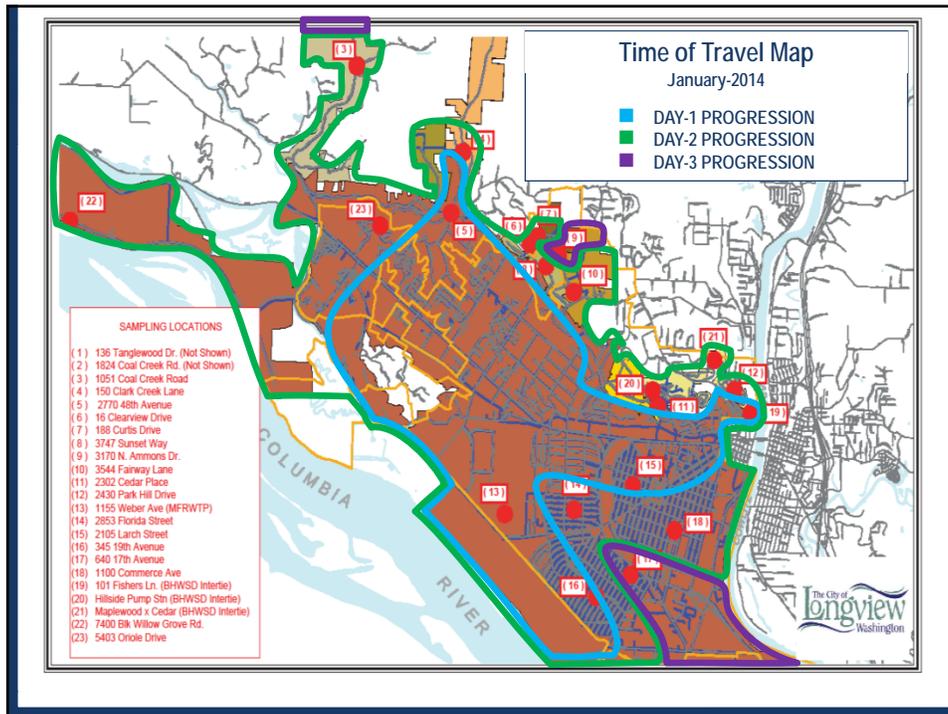
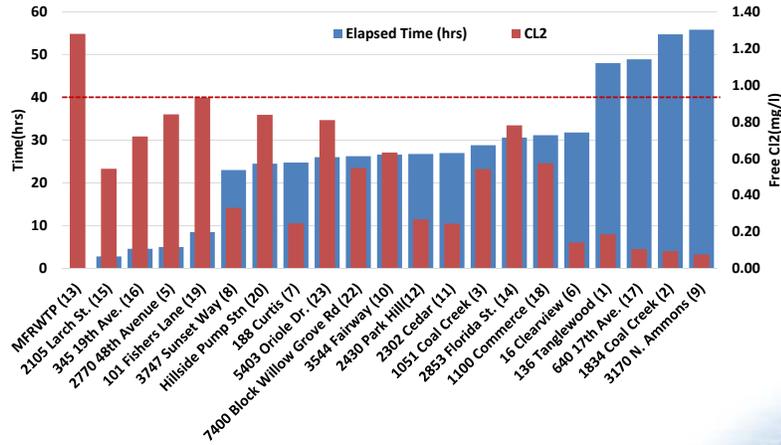
### Manganese Release Controlled when Chlorine $\geq 0.6$ mg/L - Area around 600 Block



### Causes of Chlorine Demand (Chlorine Loss)



## Travel Time vs. Chlorine at Water Quality Locations



## Progress Report - Phosphate Treatment Option

- ▶ **Evaluations:**
  - Jar tests to evaluate polyphosphate ability to reduce discoloration due to soluble iron and manganese
  - Tile spotting tests to assess impacts on white spotting
- ▶ **Findings:**
  - Moderately effective at sequestering soluble iron, minimally effective for manganese
    - Polyphosphates decay over time
    - Tracer study determined travel times
  - Did not visually reduce white spotting
  - Did not change solid phases
- ▶ **Recommendations:**
  - Do not proceed with full-scale implementation at this time
    - Unless it proves impossible to maintain chlorine residuals throughout system using other means

## White Spotting Reduction Investigations

- ▶ **What is causing the white spotting?**
  - Hardness?
  - Silica?
  - Other evaporative solids?
- ▶ **Used tile spotting tests to evaluate several treatment approaches**
  - ~~Phosphates?~~ (Not effective)
  - Softening (Calcium and magnesium removal)
  - Silica removal

## Softening/Silica Removal Bench Studies

- ▶ Compared spotting potential associated with different softening techniques
  - Ion exchange
  - Pellet softening
  - Lime softening
- ▶ Very little, if any, visual improvement observed with softening alone
- ▶ Visible improvement observed with 50% silica reduction
- ▶ Greatest improvement with 75% silica reduction

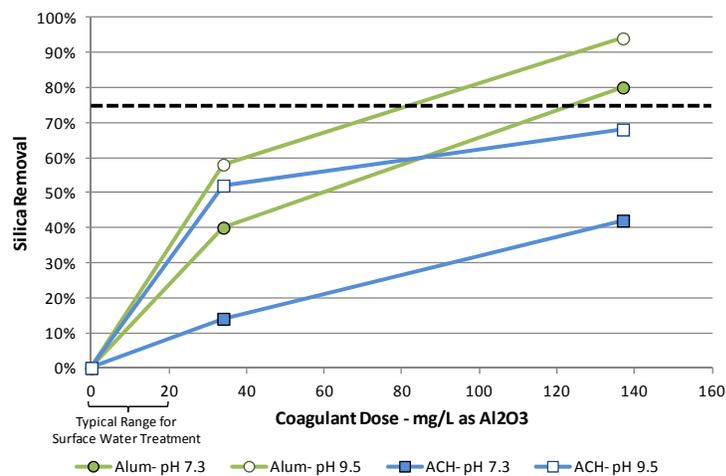
### Example Tile Spotting Results



## Silica Overview

- ▶ Naturally occurring mineral
- ▶ Unregulated in drinking water
  - Not a public health concern – no Primary MCL
  - Aesthetic issues can be unpredictable – no Secondary MCL
  - No requirement for monitoring or treatment
- ▶ Commonly added to water supplies for corrosion control
- ▶ Often evaluated for performance impacts on water treatment processes
- ▶ Not typically evaluated for aesthetic impacts on drinking water supplies since there is no secondary MCL

## Silica Co-Precipitation with Aluminum



## Silica Co-Precipitation with Aluminum

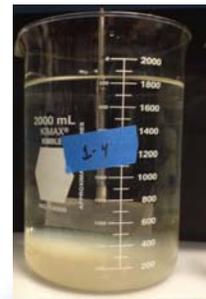
### ► Key Findings

- > 50% silica removal is attainable ... but full-scale process are very complex and expensive
  - Extremely high coagulant doses required
  - pH  $\uparrow$  9 before filters and  $\downarrow$  7.7 after filters
  - Aluminum chlorohydrate (ACH) needed to keep Total Dissolved Solids, Sulfate, and Aluminum below their SMCLs
  - Hardness is also reduced during the silica removal process



## Silica Removal Processes

- Extremely complex technologies involving major solids handling and disposal
- Magnesium Co-Precipitation
  - Replace well pumps; add finished water pumps
  - Raise pH above 10.5 and add magnesium hydroxide
  - Settle and clarify
  - Lower pH back to 7.7 and add alkalinity back in
- Alum Coagulation
  - Replace well pumps; add finished water pumps
  - Raise pH above 9 and add aluminum chlorohydrate (novel technique)
  - Settle and clarify
  - Lower pH back to 7.7 and add alkalinity back in



## Costs For Silica Removal Systems

- ▶ **Magnesium Co-Precipitation: \$37 million**
- ▶ **Aluminum Coagulation: \$35 million**
- ▶ **Reverse Osmosis: \$81 million**
  
- ▶ **Costs include design, construction, permitting, construction management and 30% contingency**



## USEPA Office of Research and Development Spotting Analysis



Cincinnati Tap Water	Longview POE Water	Longview POE w/Phos.	Customer Control Area	Customer Problem Area	Site 17	Site 17 w/Phos.
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pH	8.5	pH	7.7
Ca	34.7	Ca	26.4
Mg	10.4	Mg	5.8
Na	26.2	Na	18.0
Cl	27.6	Cl	26.3
SiO <sub>2</sub>	4.8	SiO <sub>2</sub>	50.0



## Comparison of Solids Formed



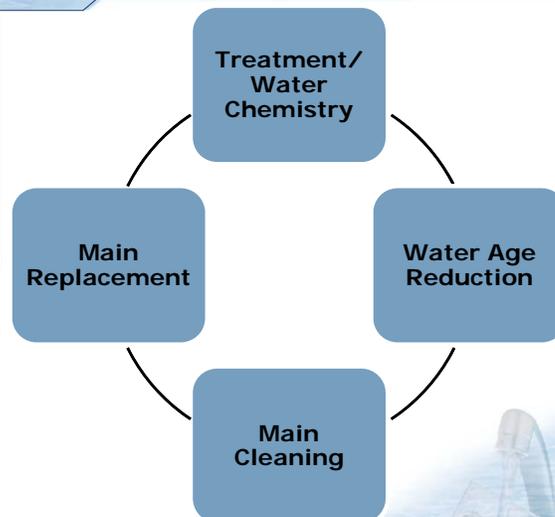
## Conclusions – White Spotting

- ▶ **Primary cause of white spotting has been identified**
  - **Primarily associated with naturally-occurring silica, not hardness or other dissolved solids**
    - CaCO<sub>3</sub> chemistry does not support precipitation
    - Qualitative visual comparison
    - USEPA solids analyses (preliminary)
  - **Evaporative process, no evidence of accumulation in distribution system**
- ▶ **Softening not likely to make significant improvement**
- ▶ **Silica removal very complex and expensive**

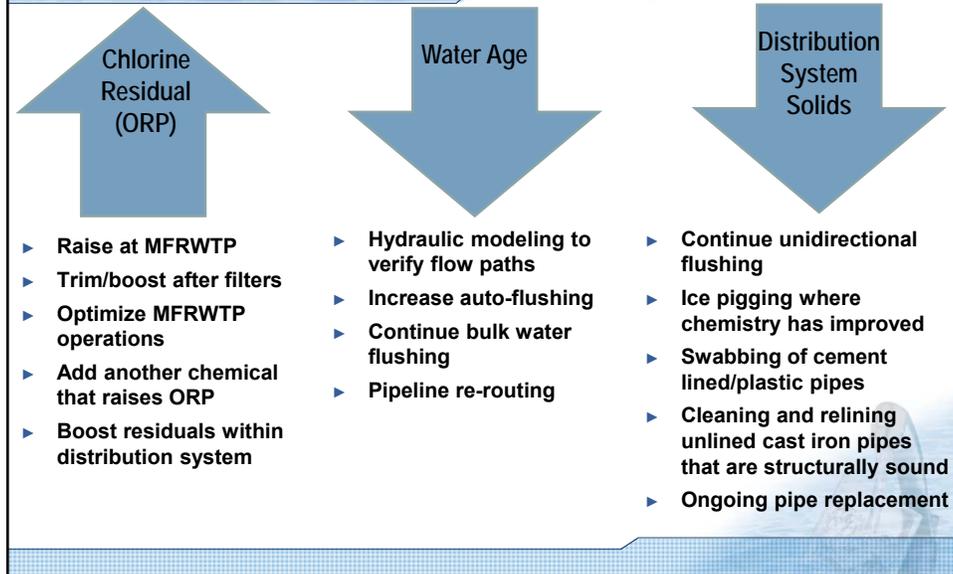
## Conclusions – Water Quality

- ▶ **Causes of discolored water have been identified**
  - Considerable tuberculation of unlined cast iron mains due to 67 years of corrosive Cowlitz River water
  - Difficulty maintaining disinfectant residuals due to changes in flow direction, water age, and pipe wall demands in Baltimore Street area
- ▶ **Conditions have improved in many, but not all, areas of the distribution system**
- ▶ **Discolored water can be largely controlled if disinfectant residuals are maintained >0.6 mg/L**
- ▶ **Additional chemical treatment should be avoidable if residuals can be maintained**

## Recommended On-Going Water Quality Mitigation Strategies



## Options/Recommendations



## In Summary....

- ▶ It has been a long and difficult road....
- ▶ The primary cause(s) of distribution system water quality problems have been identified
- ▶ Effectiveness of mitigation strategies have been demonstrated
- ▶ Standard and novel approaches have been evaluated
- ▶ City has new tools to assess water quality conditions
  - Robust database; Tile spotting tests; Pipe rigs
- ▶ Unfortunately, white spotting issues are a nuisance that cannot be easily mitigated at the treatment plant
  - Avoid expensive additional treatment that likely would not be effective
- ▶ Existing treatment and O&M capabilities can be maximized to continue distribution system water quality improvement
- ▶ The Mint Farm RWTP produces water of very high quality. Process optimization is on-going

