

Presented at
PNWS-AWWA
Annual Conference
Spokane, Washington
May 9, 2013

Good Coagulation Chemistry Provides Robust Solution to Intriguing New Challenge

Unexpected Effects of Climate Change on Water Quality

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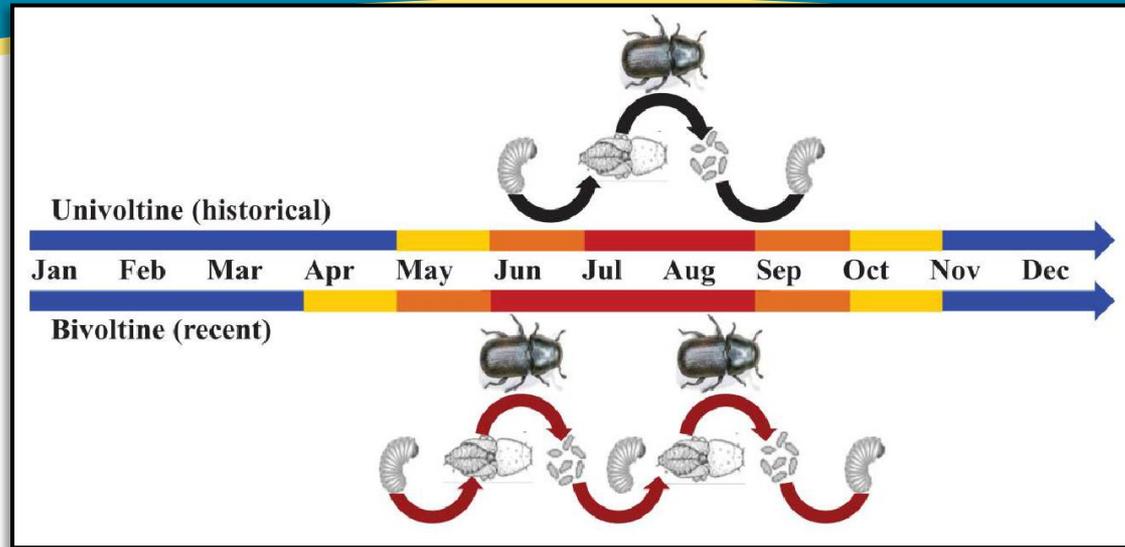
BUILDING A BETTER WORLD

Outline

- Linking Climate Change to Changes in Water Quality
- Impacts on the Butte Silver-Bow (BSB) Water System
- Big Hole Water Treatment Plant, Butte MT
 - Jar Testing Results
 - Pilot Scale Results
- Recommendations for BSB
- Considerations for the Pacific Northwest



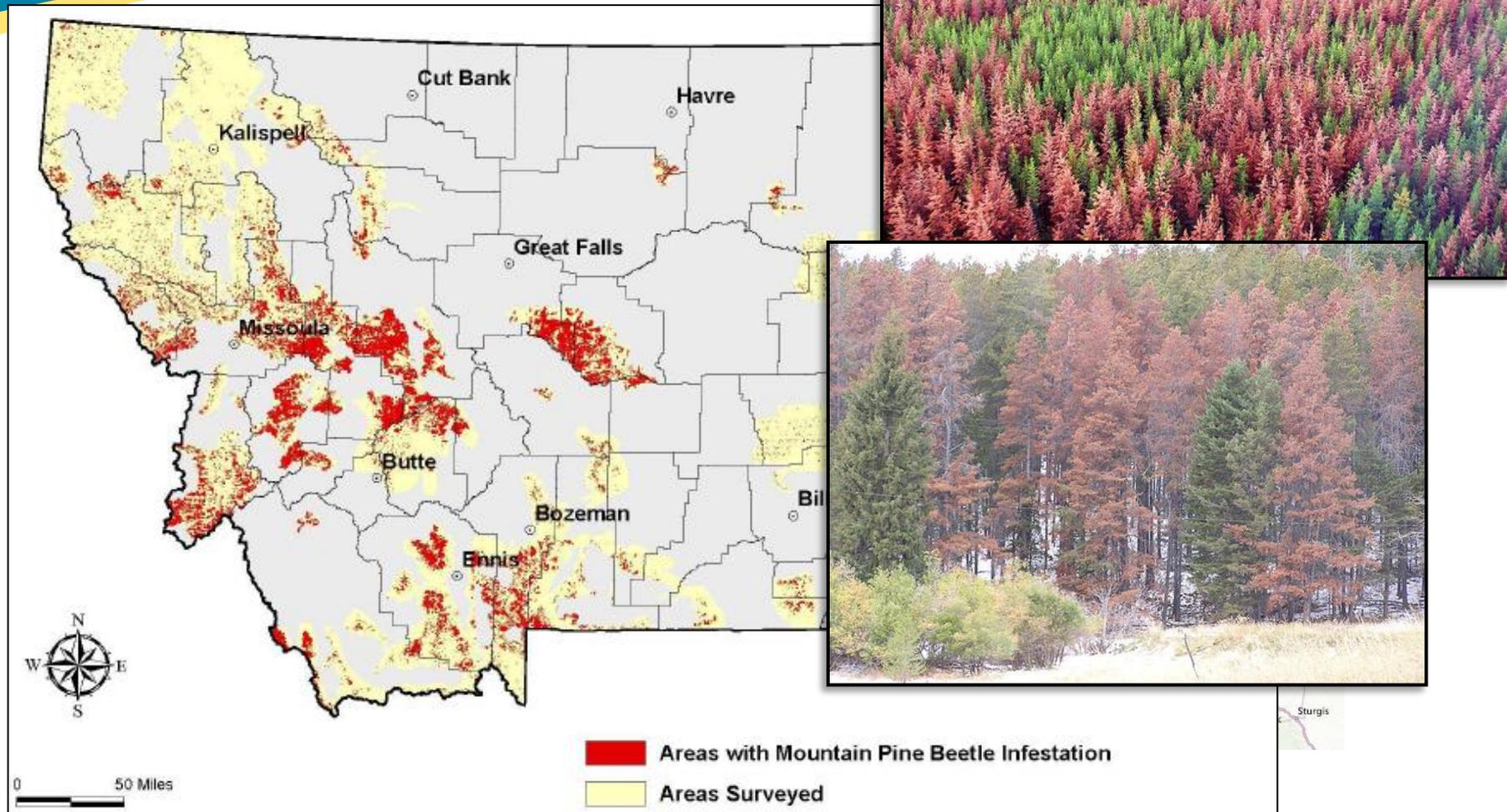
Pine Beetles and Climate Change



- “Climate Change Type Drought” leave trees more vulnerable
 - Barbara Bentz, U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. 2008.
- Warmer winters are not killing off pine beetles
 - K. Stahl, R. D. Moore and I. G. McKendry; Department of Geography and Department of Forest Resources Management, The University of British Columbia. August 2006.
- Warmer temperatures allow 2 generations per year
 - Jeffry B. Mitton and Scott M. Ferrenberg, Department of Ecology and Evolutionary Biology, University of Colorado. March 2012.



Pine Beetle in Montana



USDA and USFS Pine Beetle Surveys - 2011



Pine Beetles and Water Quality

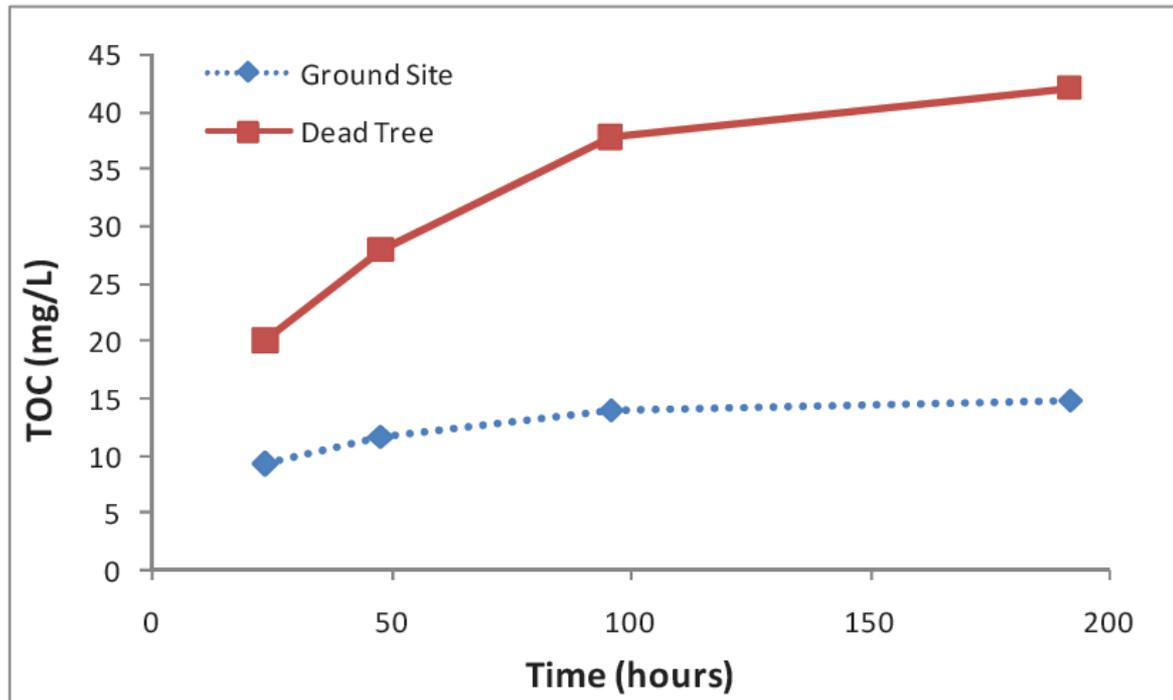


Figure 1. Organic matter leached from needles from a standing dead tree and from needles from a ground site.

“There is a great potential for increased organic loading within the watershed due to the large volume of dead and decaying pine tree litter in the region.”

- Research at
University of Colorado,
Boulder

Disinfection By-Product Formation from Dissolved Organic Matter Produced from Pine Beetle Epidemic in Rocky Mountains By Katherine M.H. Beggs and R. Scott Summers



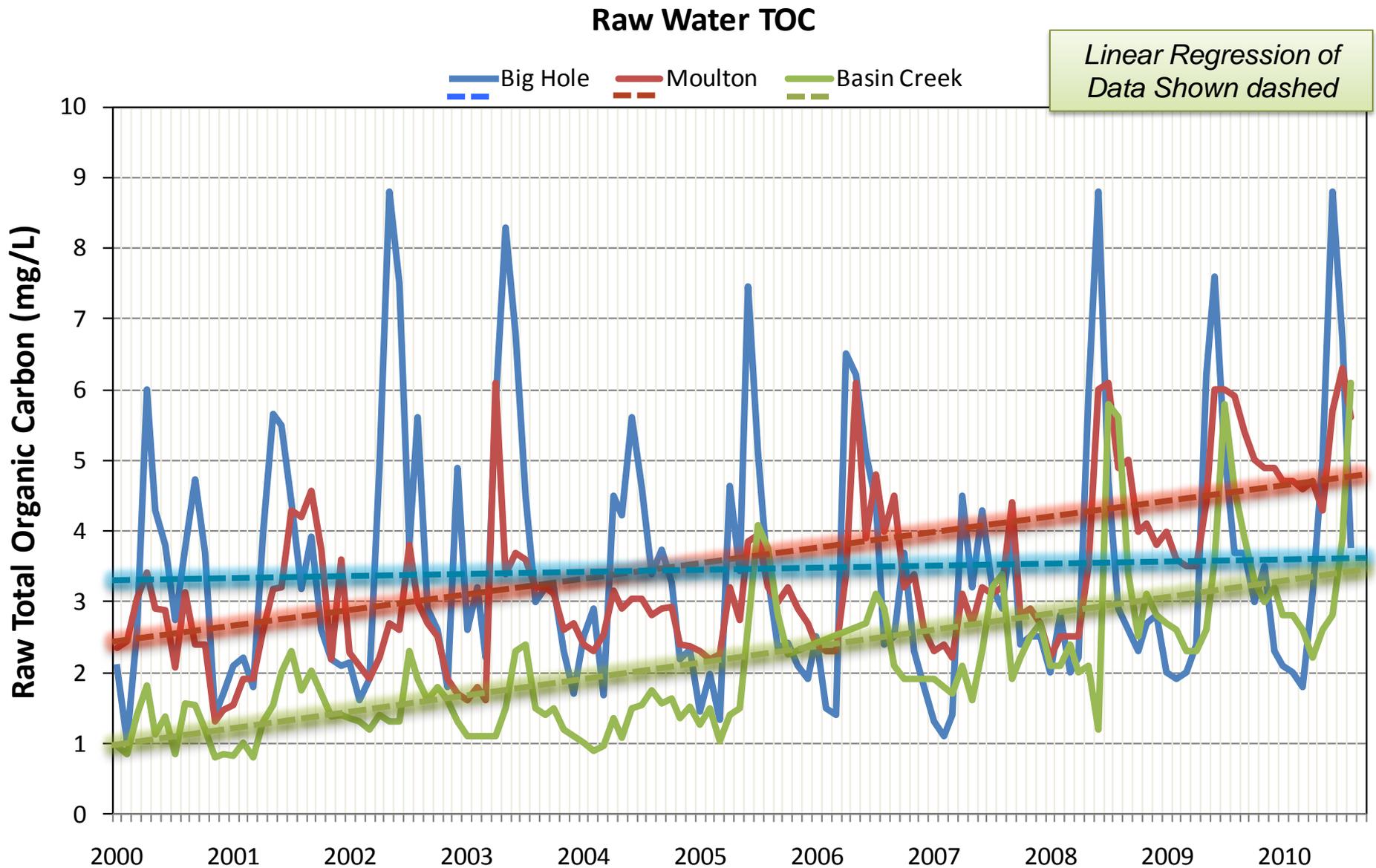
Butte-Silver Bow Water Division

Water System Overview

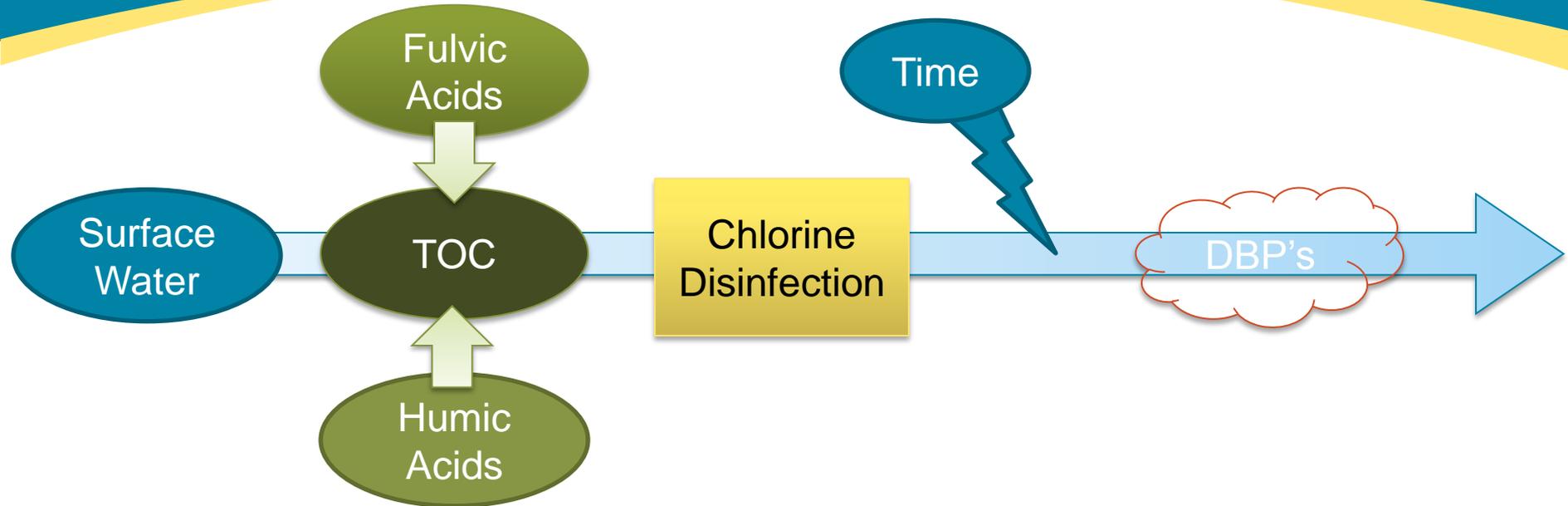
- Moulton WTP
 - Packaged,
Conventional
- Moulton Reservoir
- Basin Creek Reservoir
 - Unfiltered
- Big Hole WTP
 - Dual Filtration
- Big Hole River Diversion Dam



TOC Changes in Butte, MT



Total Organic Carbon (TOC) and Disinfection Byproducts (DBP's)

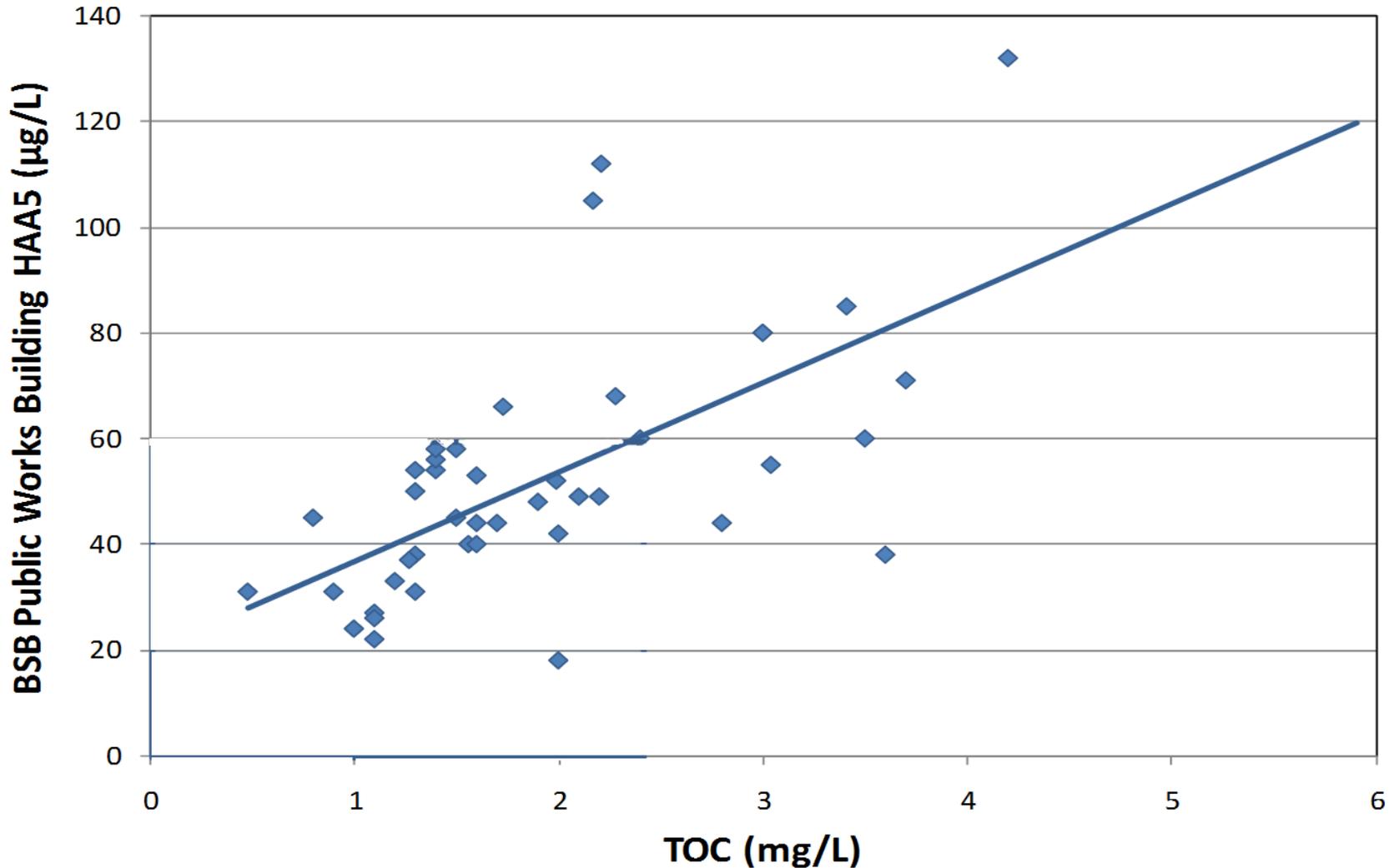


- There are several kinds of DBP's including
 - Haloacetic Acids (HAA5's)
 - Trihalomethanes (THM's)
- DBP's are linked to health issues such as cancers, nervous system disorders and birth defects



TOC Affects Disinfection By-Product Formation

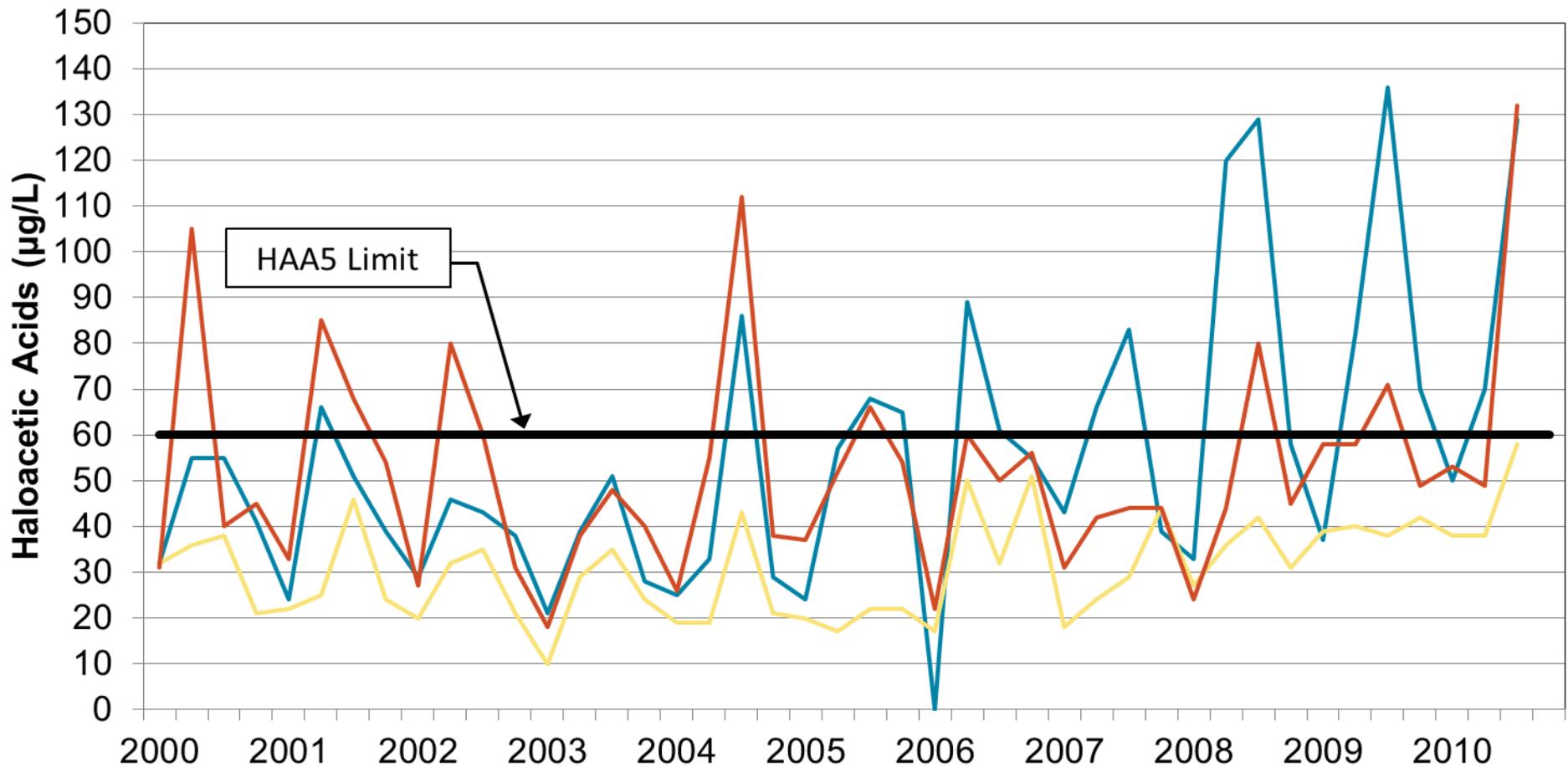
Big Hole WTP HAA5 vs. Post-Filter TOC



DBP Changes in Butte, MT

Butte Silver Bow Water System Haloacetic Acids

— Basin Creek Supply — Moulton Supply — BHWTP Supply



Impacts on BSB System

Problem: Increased TOCs lead to exceedances in HAA5 levels

Regulatory Response:

- Filtration waiver for Basin Creek was revoked
- Stage 1 D/DBP Rule: Big Hole WTP reclassified as a convention plant
 - Now required to meet TOC removal requirements
- Stage 2 D/DBP Rule: Locational Running Annual Averages
 - Makes it harder for BSB to comply using existing facilities

Solution: Upgrade the Big Hole.



DBP and TOC Control Options for Big Hole

Non-
Treatment

Alternative
Disinfection

Treatment

Source Water
Blend Finished
Water

Chloramines
Ozone
UV

**Remove
Organics**

Alter Organics

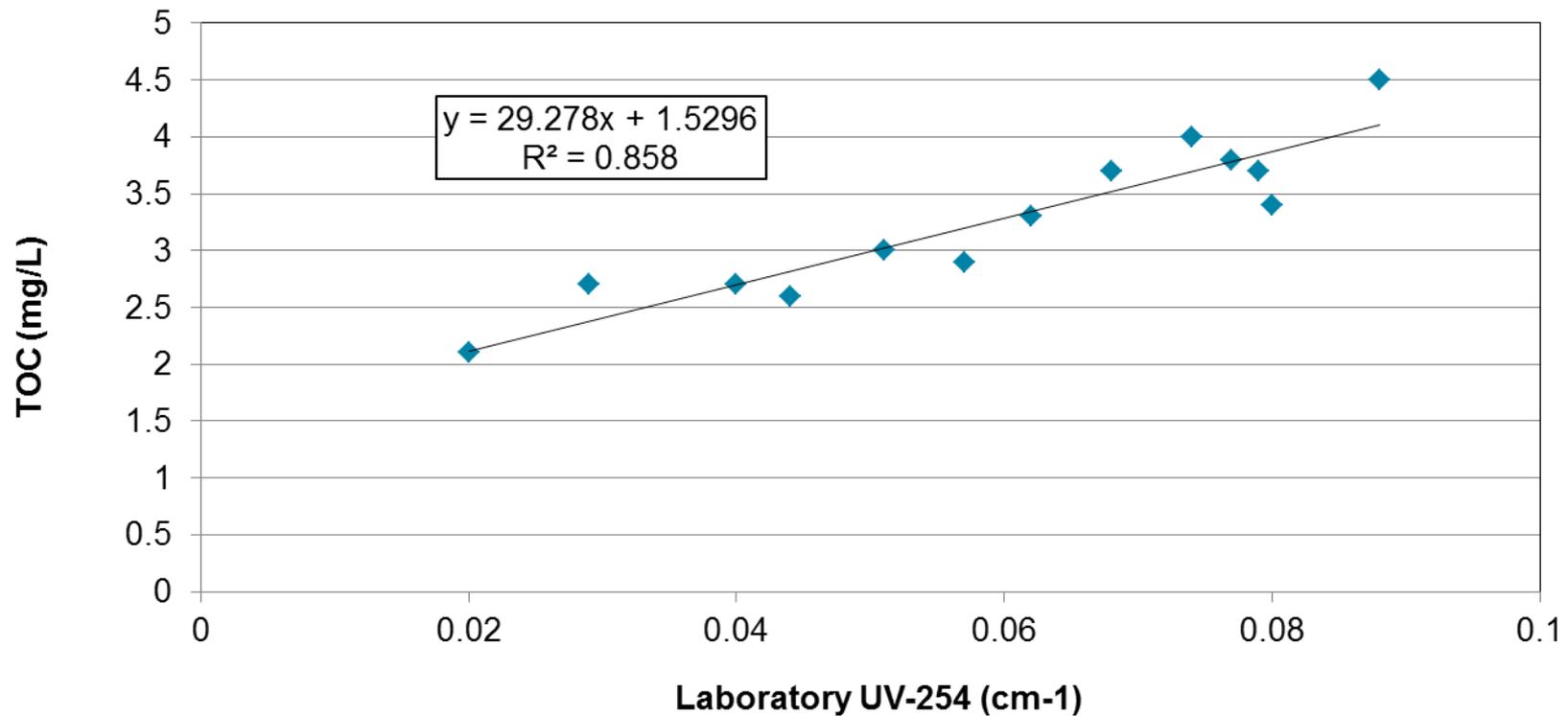
**Enhanced
Coagulation**

Adsorption
Softening
Membranes
Ozone +
Biofiltration

Ozone

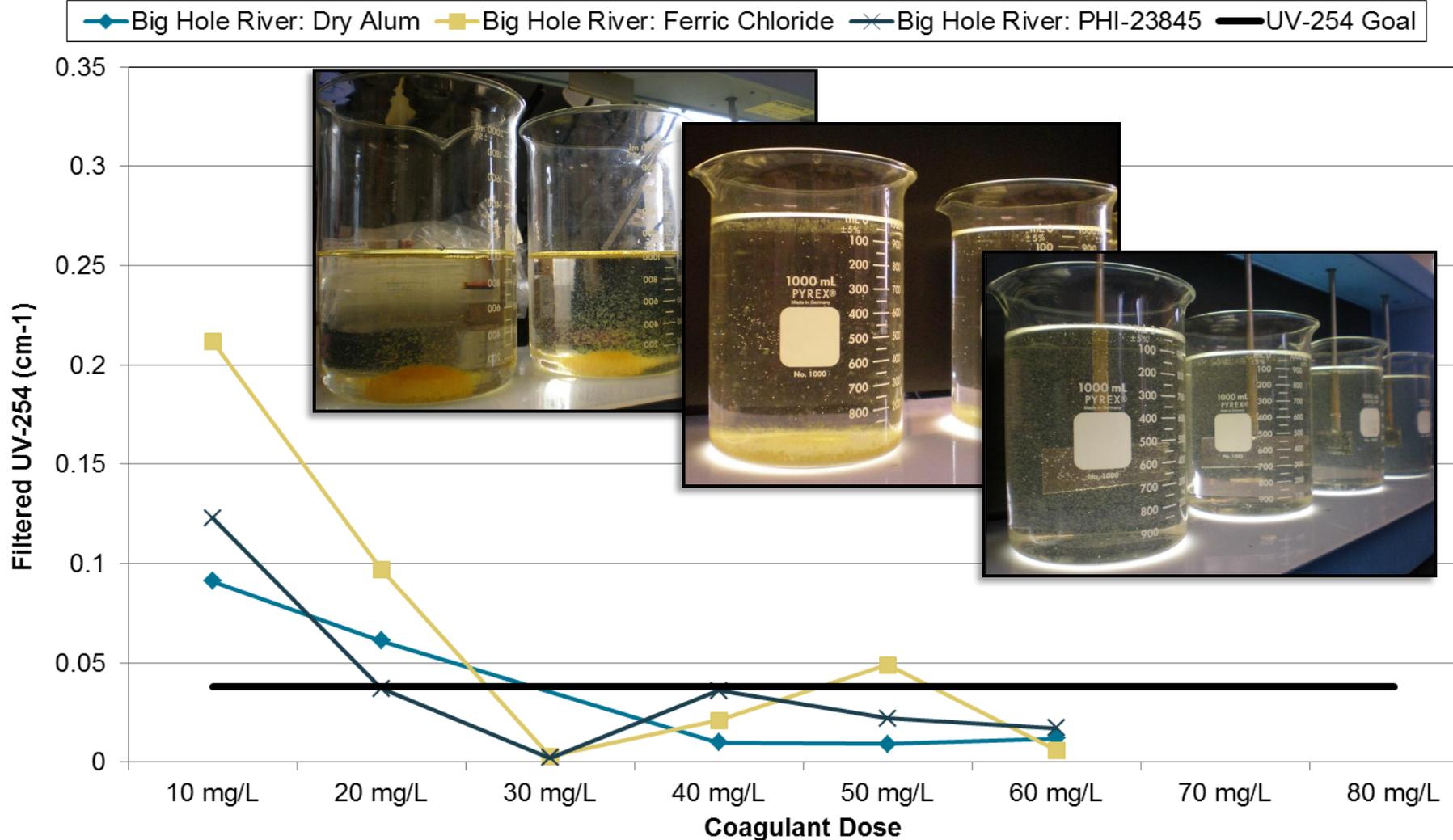
Jar Testing – TOC vs. UV-254

TOC vs UV-254, Big Hole River Water Jar Tests



Jar Testing – Results

Traditional and Proprietary Coagulants



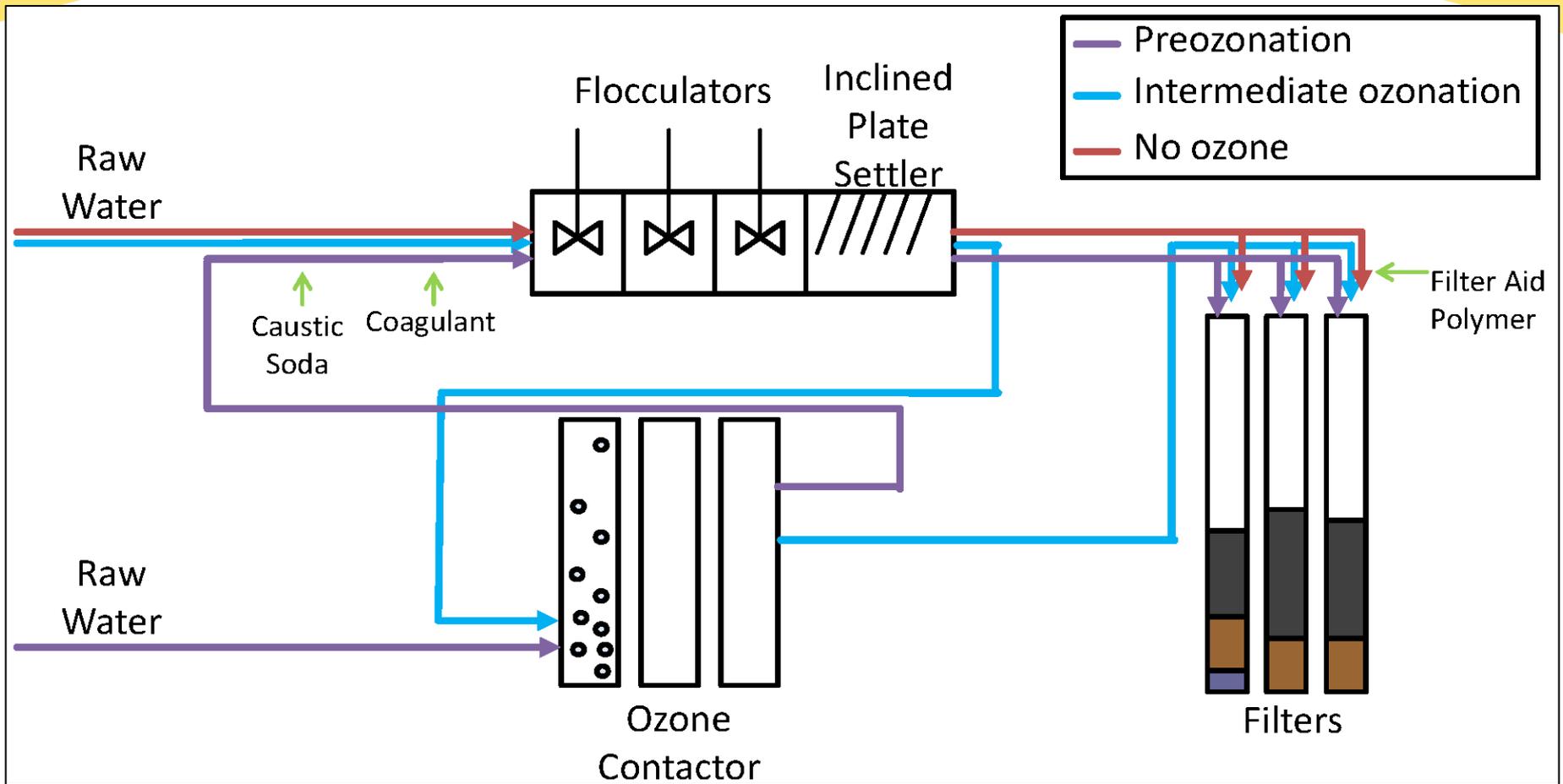
Pilot Testing

- Pilot Testing during Summer 2011
 - Capture high TOC and color events
- Goals
 - Reduce DBP Formation
 - Increase TOC Removal
 - Increase Plant Capacity

*Equipment provided by
MWH Research*

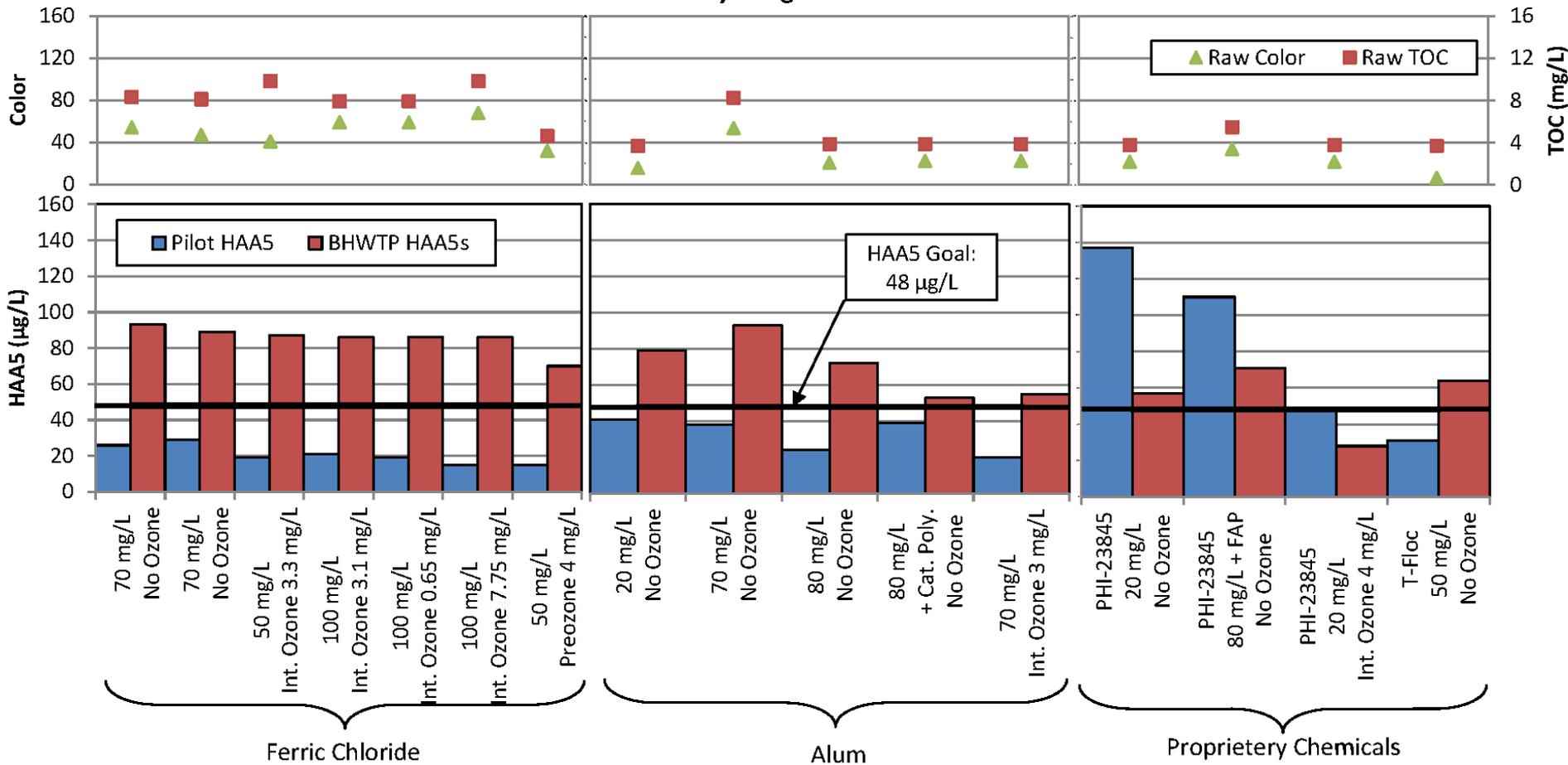


Pilot Testing Configuration



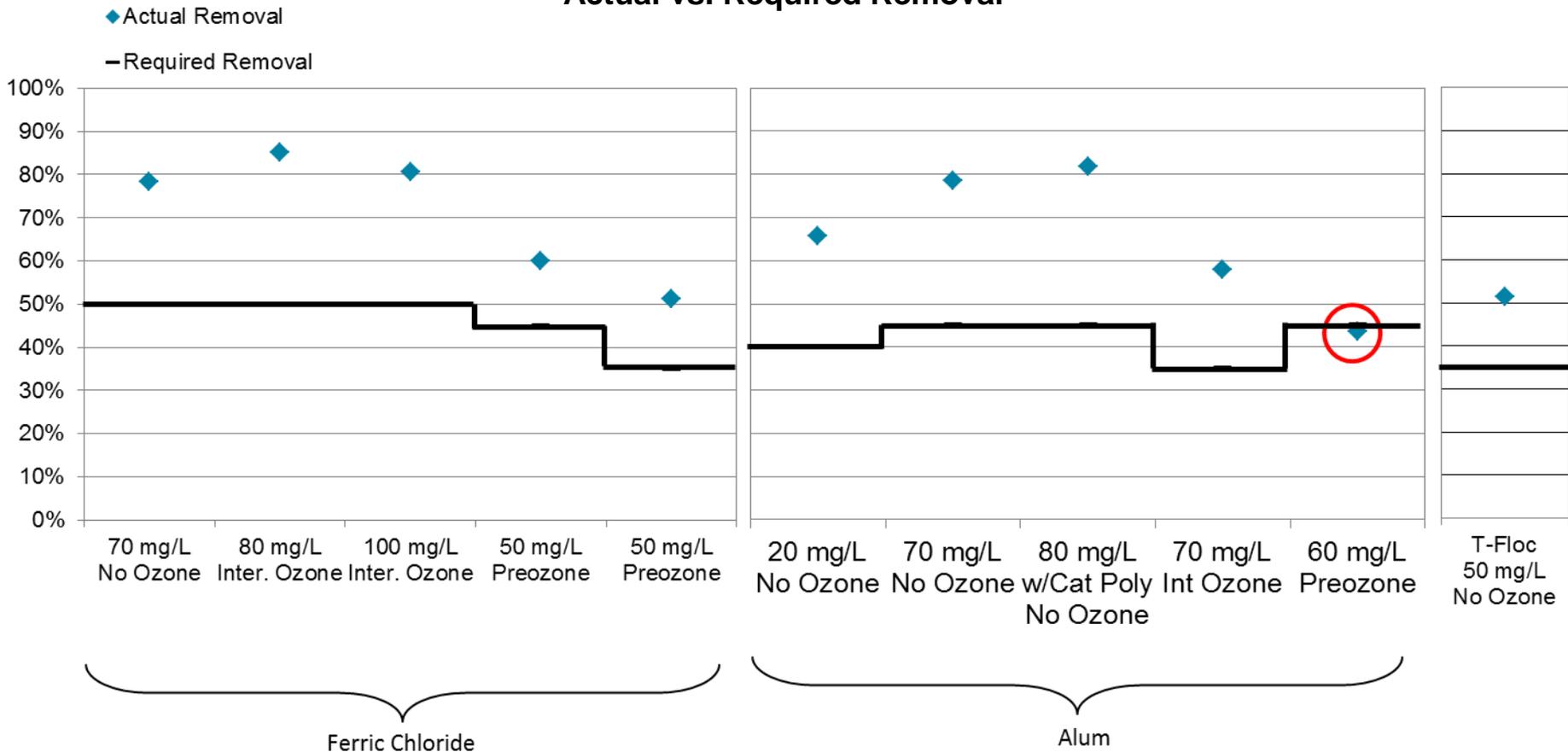
Pilot Results – DBP Reduction

HAA5, Raw TOC and Raw Color by Coagulant



Pilot Results – TOC Removal

TOC Removal Actual vs. Required Removal

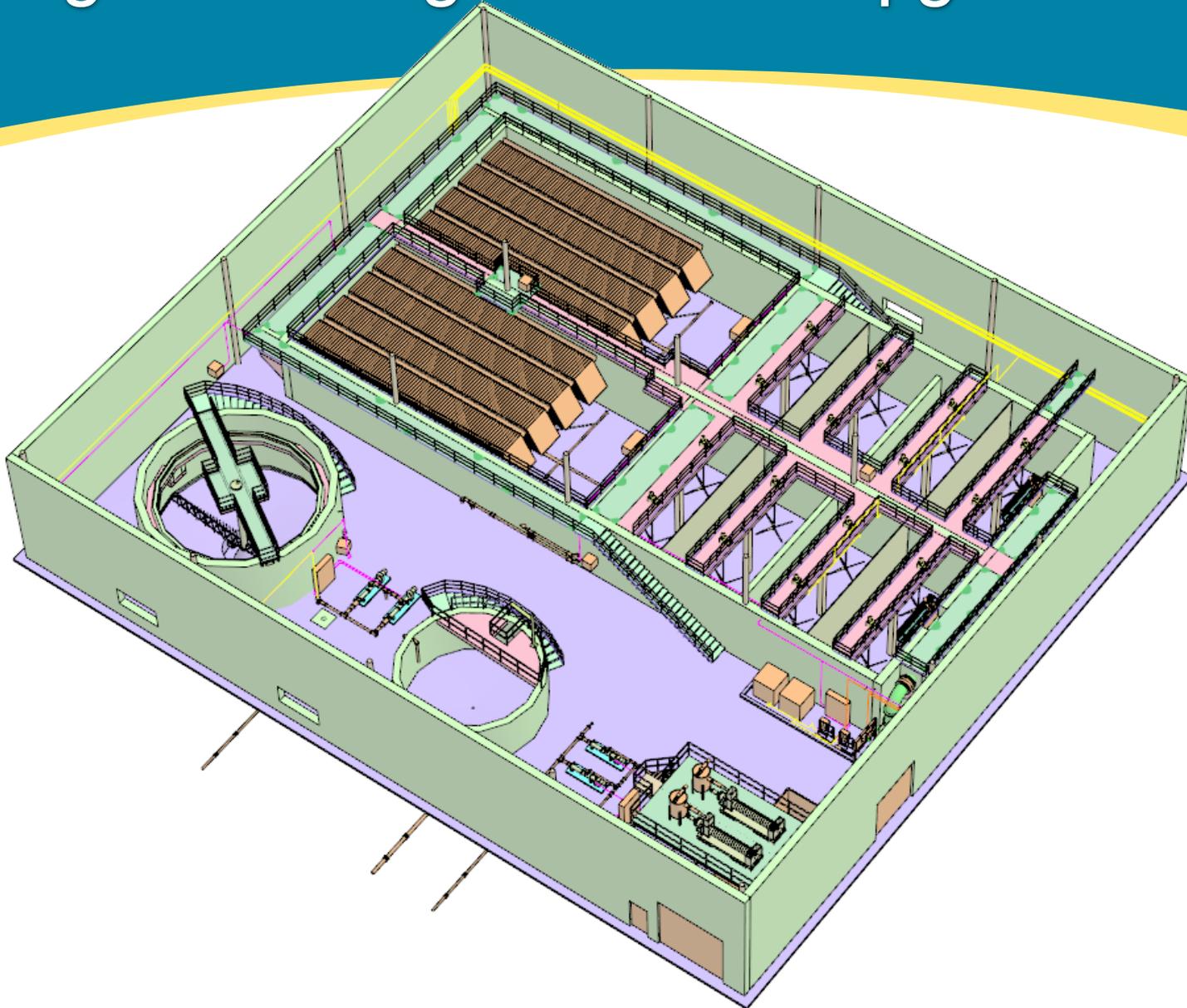


Recommendations for BSB

- Upgrade Big Hole WTP for increased TOC removal
 - Install flocculation/sedimentation basins
 - Design the plant for increased capacity of 16 mgd
 - Install solids handling equipment to handle increased solids production
- New Basin Creek WTP
 - Comply with DEQ requirements to filter this source
 - 7 MGD with floc/sed, filters and solids handling.



Design of the Big Hole WTP Upgrade



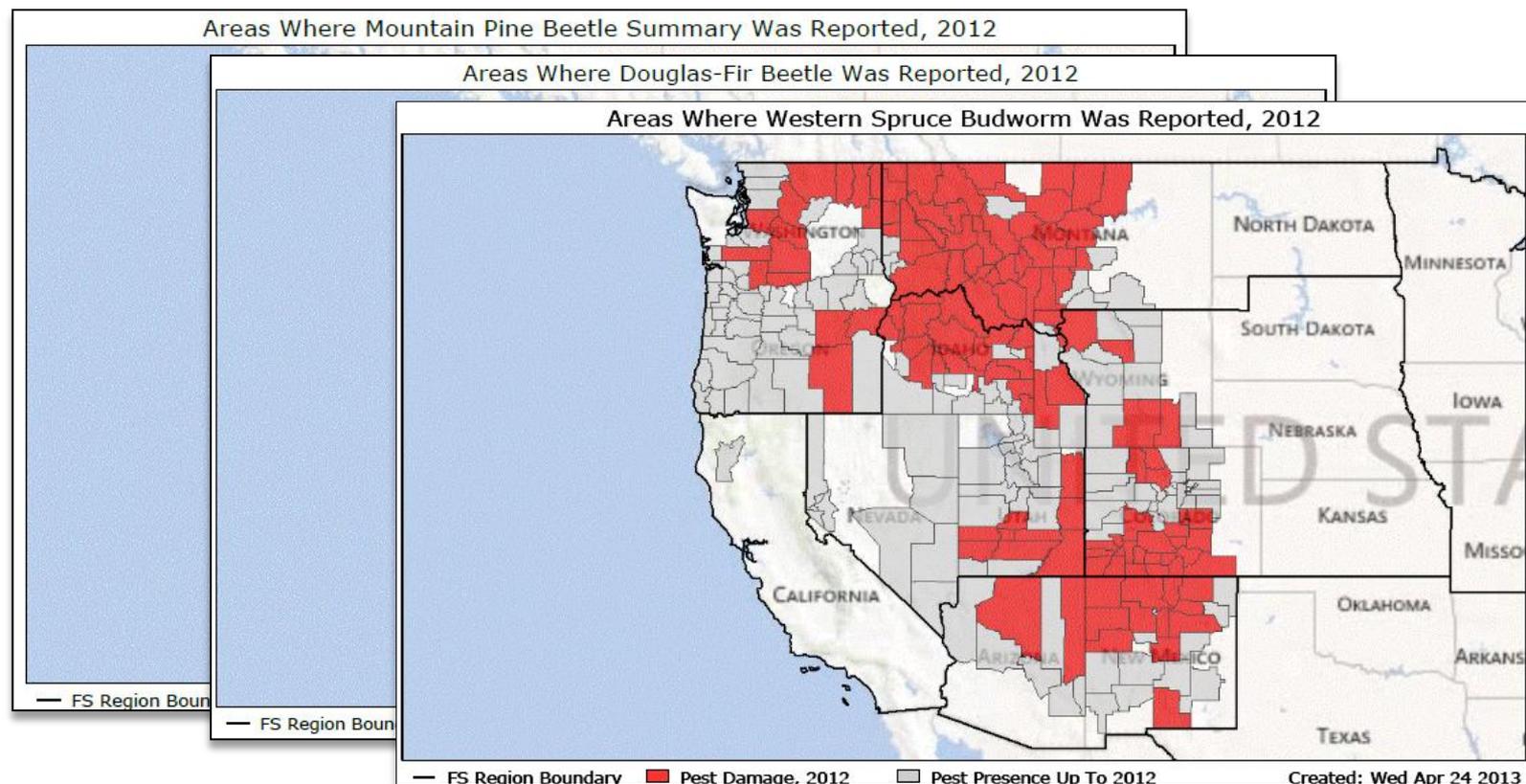
Conclusion

- Climate change → More Pine Beetles → Increased organics and DBPs
- Enhanced coagulation can remove organics and reduce DBPs
- Bench scale: proprietary and traditional coagulants are viable
- Pilot scale: traditional coagulations performed better



Consideration for the Pacific Northwest

- Conifers in the Pacific Northwest are susceptible to a number of forest pests including the Mountain Pine Beetle, Douglas Fir Beetle, and Western Spruce Budworm



Acknowledgements

City and County of Butte Silver-Bow: Water Division

Rick Larson, Operations Manager – Water Utilities Division

Doug Finnicum, Chief Operating Engineer – Water Utilities Division

Jim Dennehy, Regulatory Compliance – Water Utilities Division

Jim Kennan, Treatment Operating Engineer – Water Utilities Division

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Questions?



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