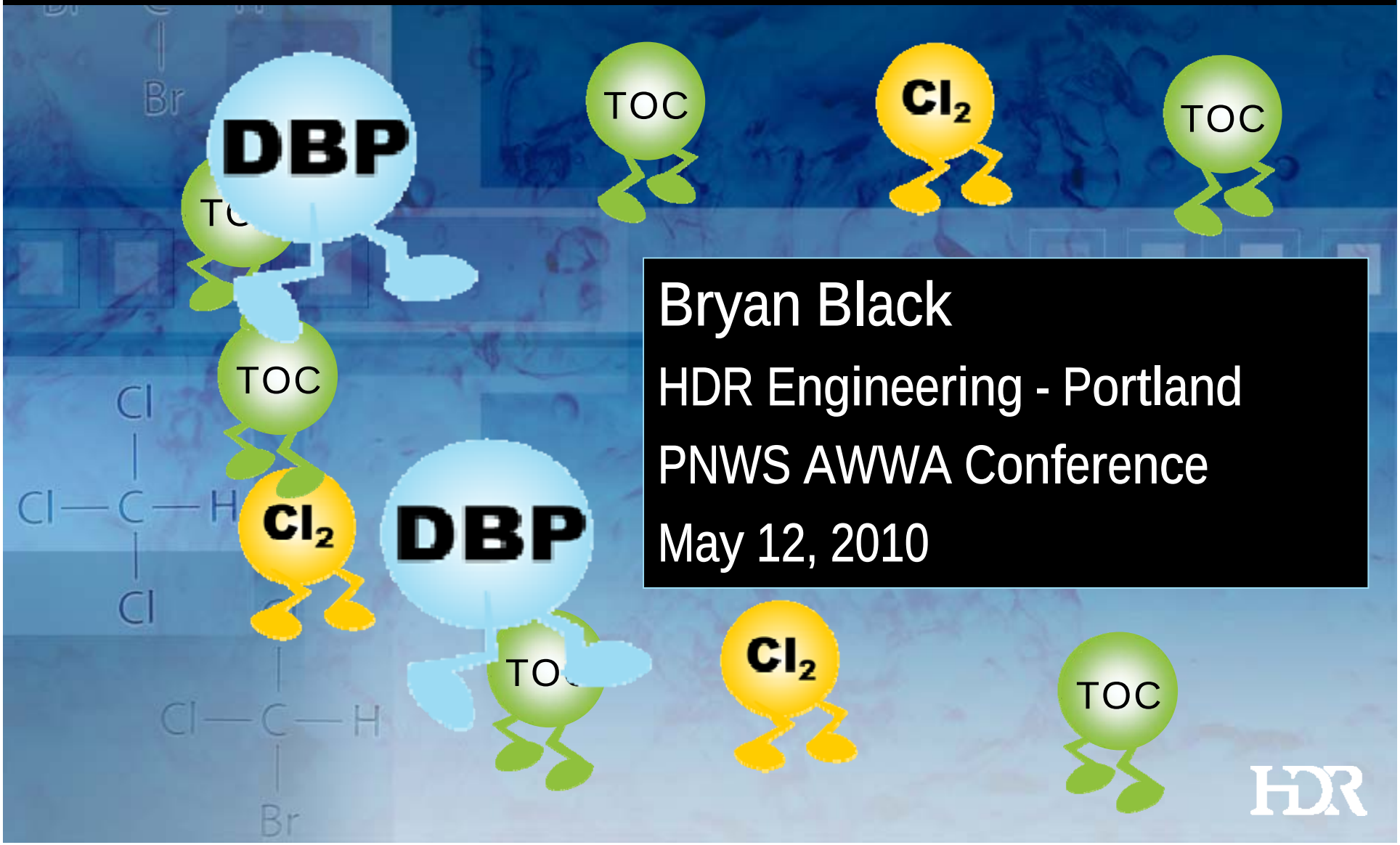
Water Quality and Treatment for ASR Injection Water



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PNWS AWWA Conference

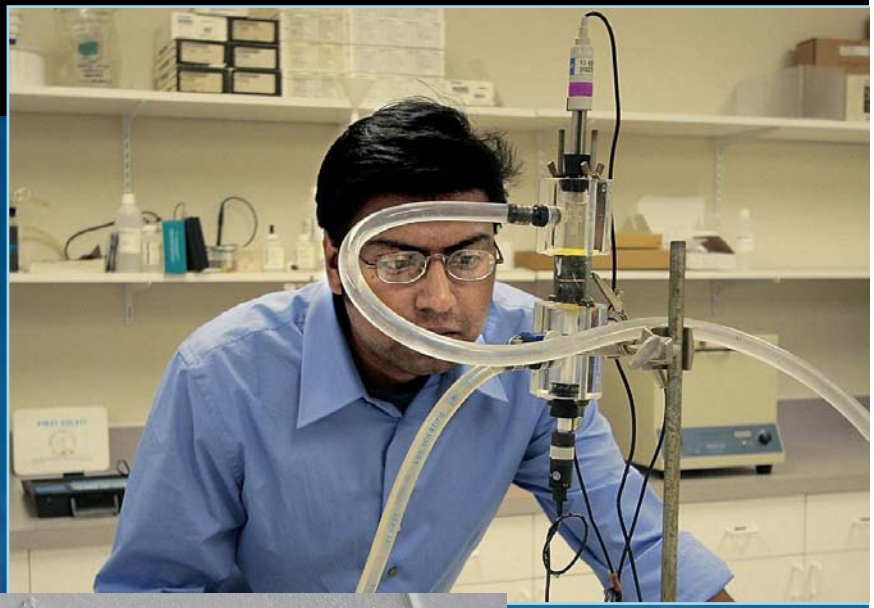
May 12, 2010

Presentation Overview

- Injection water quality needs
- Raw water sources / quality issues
- Impact of treatment on finished water quality
- Regulatory environments and issues
  - Oregon
  - Washington
- Case studies

Typical injection water quality requirements

- Turbidity < 0.5 ntu
- Noncorrosive
- Geochemical compatibility
- Redox compatibility
- Others



Potential injection water sources

- Surface water
  - River
  - Lake
- Ground water
  - Alluvial aquifer
  - Adjacent aquifer
- Wastewater effluent

Typical source water quality issues

Surface water

- Protozoa, Viruses, Bacteria
- Natural organics
- Turbidity
- Lake
  - Algae
  - Iron
  - Manganese

Groundwater

- Iron
- Manganese
- Nitrate

Wastewater

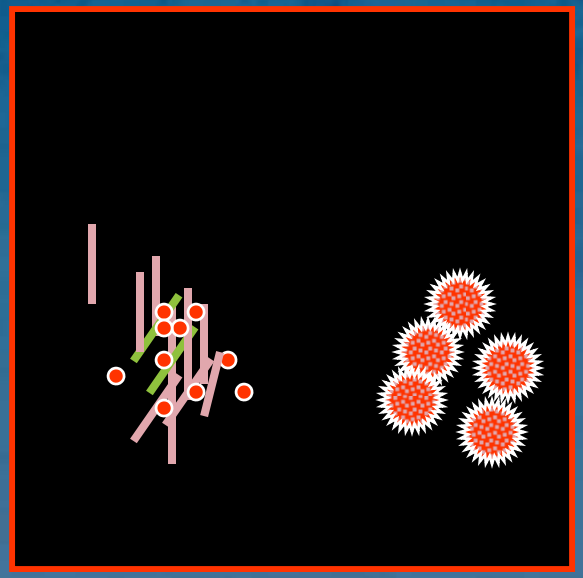
- Microbial pathogens
- NDMA
- Micro pollutants

Water Treatment Key Objective: Removal / Inactivation of Microbial Pathogens

Pathogenic bacteria, viruses and protozoa in *water and* wastewater represent potential risks to public health.

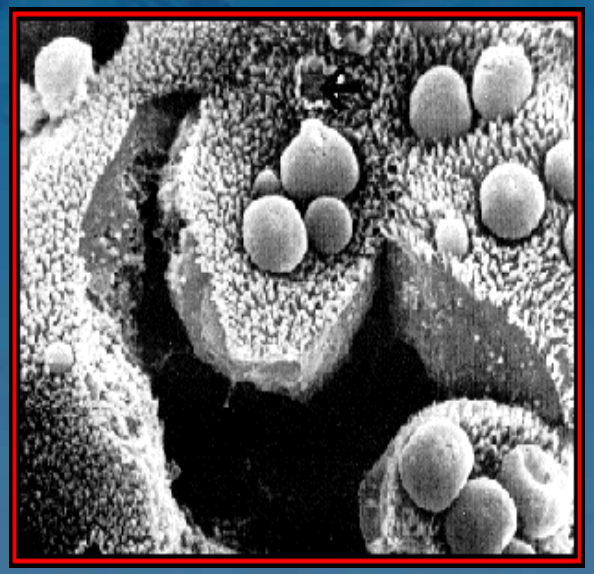
Bacteria (*E.coli*)

Viruses (Hepatitis, Polio)



Protozoa (*Giardia*)

Protozoa (*Cryptosporidium*)



Water treatment techniques / requirements

SDWA (1990) “Dual Barrier” treatment techniques

- Filtration:
  - Removes some microbes (larger ones)
- Disinfection:
  - Inactivates remaining microbes
- Disinfectants / Disinfection Byproducts Rule
  - Regulated trihalomethanes, haloacetic acids, others
  - Enhanced coagulation: remove natural organics

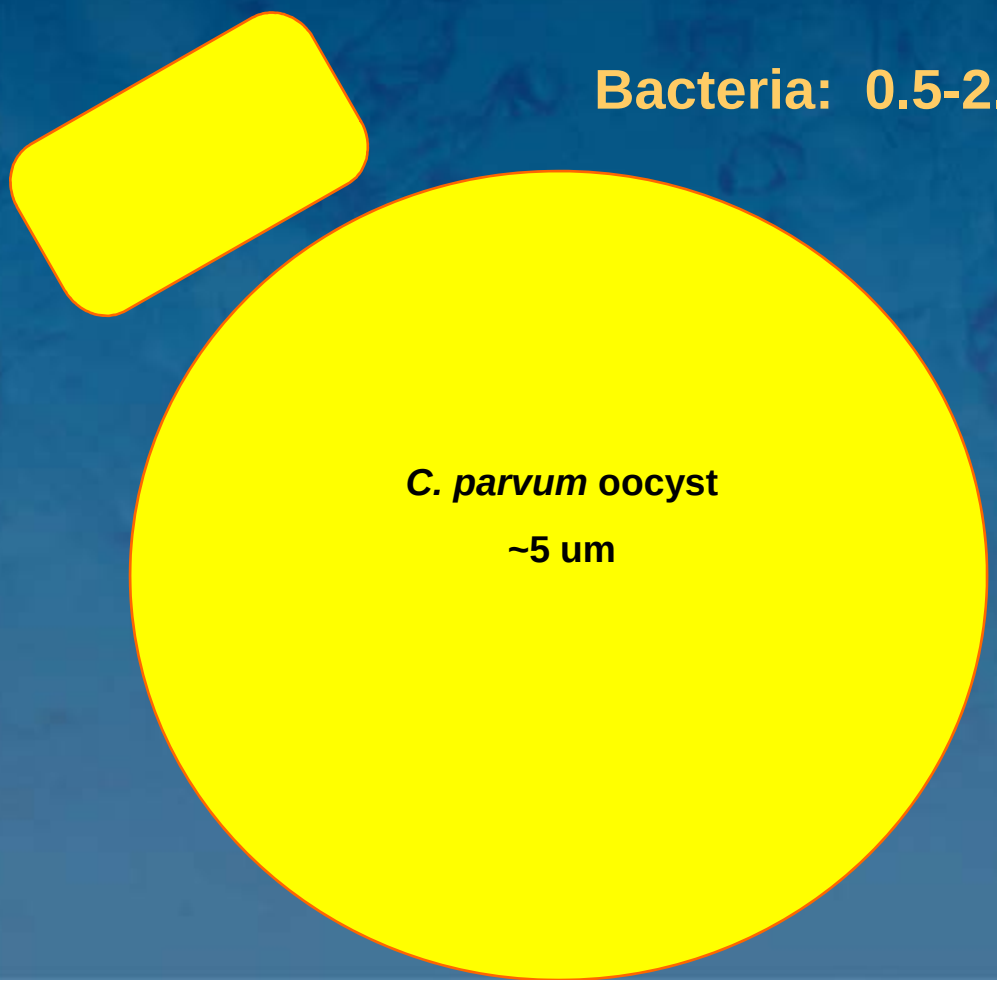
Classes of Microorganisms: The Microbial World

- Viruses: smallest (0.02-0.3 µm diameter)

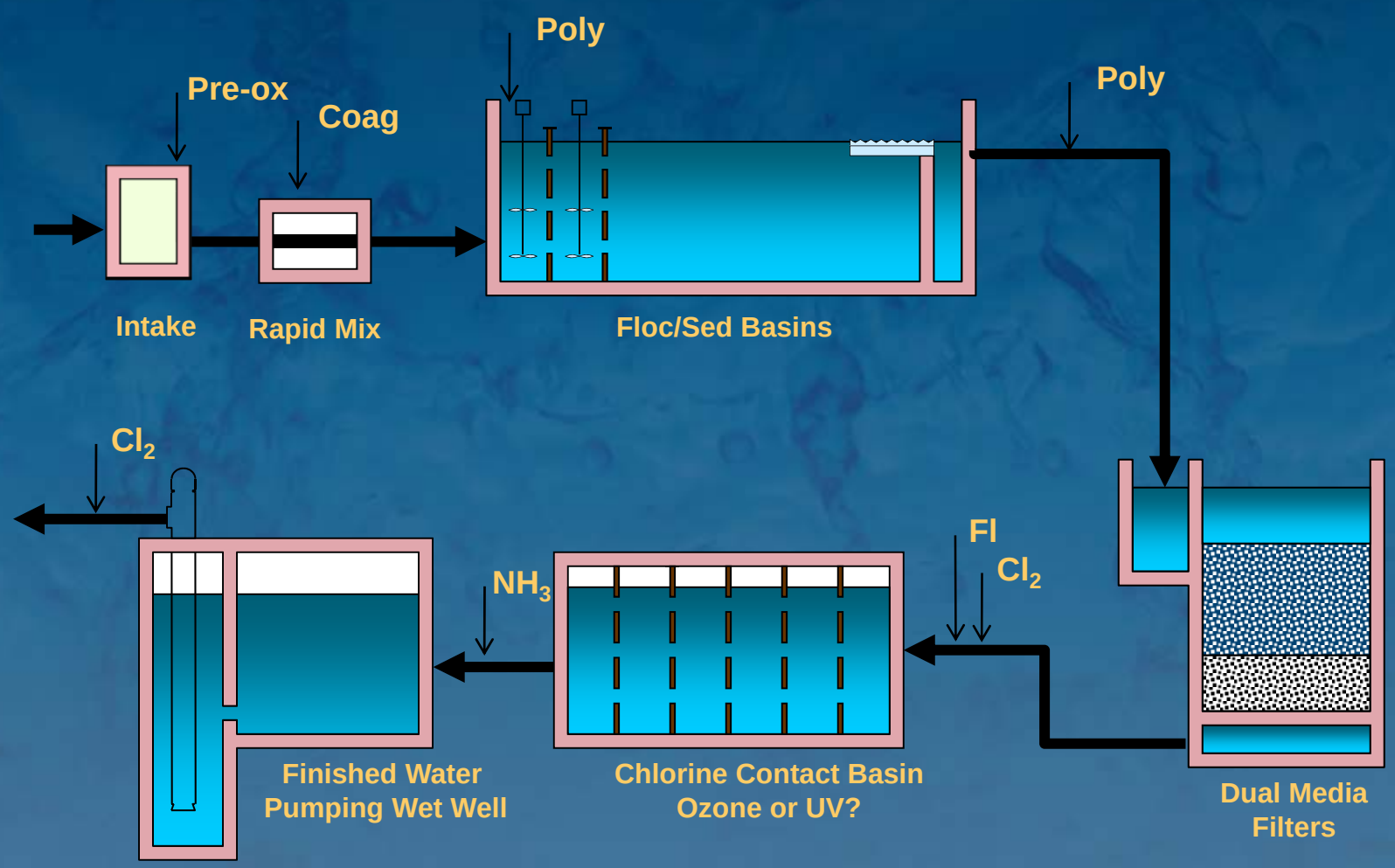
Bacteria: 0.5-2.0 µm diameter (e.g. *E. coli*)

Protozoa: most >2 µm - 2 mm; (hardy cysts and oocysts)

(e.g. Giardia, Cryptosporidium)

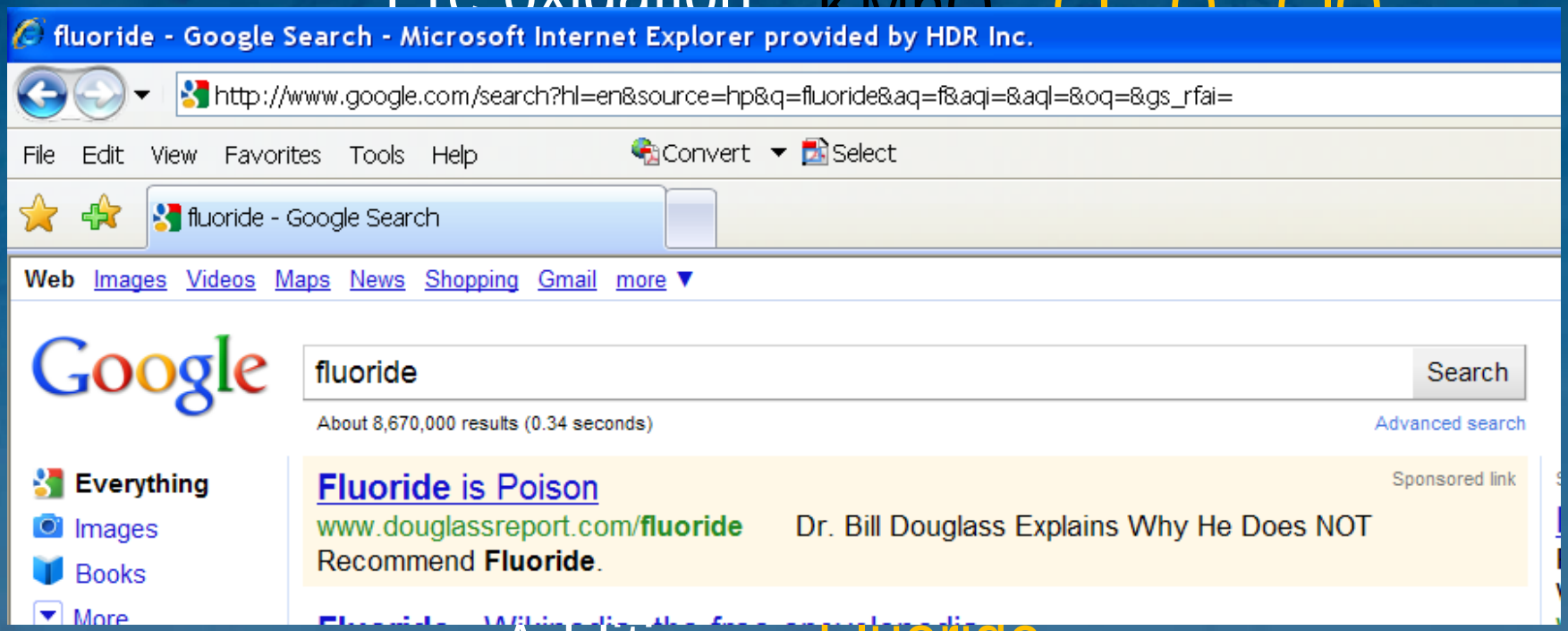


Conventional treatment relies on chemical additives



Water treatment techniques and chemical addition

Pre-oxidation: $KMnO_4$, Cl_2, O_3, ClO_2



Additives: Fluoride

Disinfection creates chemical byproducts

Chemical Disinfectant + **Precursor** = **DBPs**

Chlorine
Chloramines
Ozone
Chlorine Dioxide

+

Natural Organics
Bromide

=

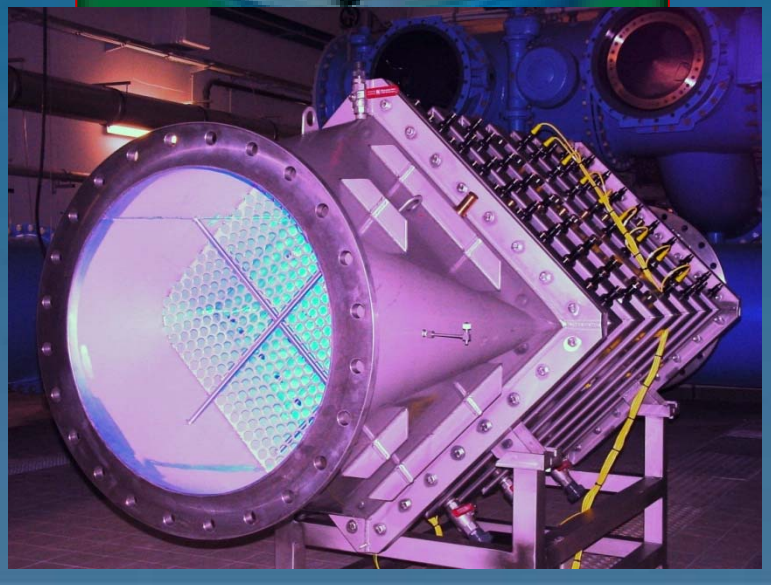
Trihalomethanes
Haloacetic Acids
Bromate
Chlorite / ate
Haloacetonitriles
Haloketones
Aldehydes
and many more

Disinfection: No Silver Bullet

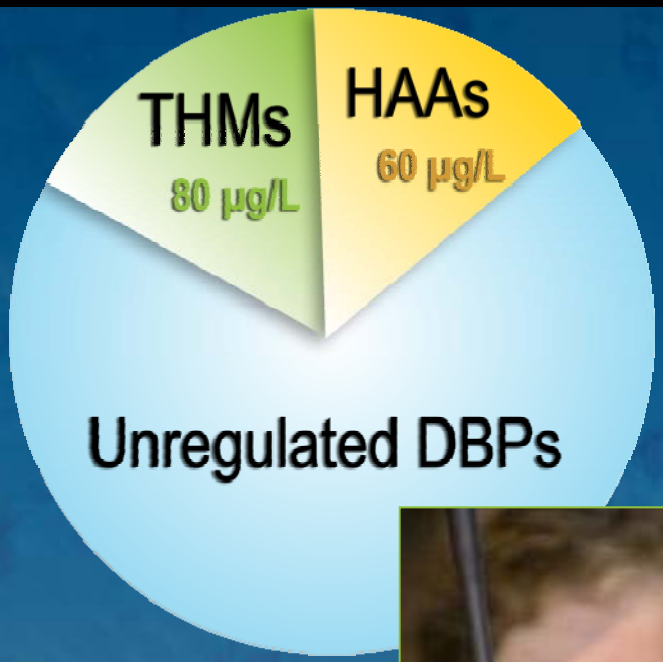
	Chlorine	UV	Chloramine
Giardia	Fair (slow)	Excellent (fast)	Poor
Crypto	Ineffective	Excellent	Ineffective
Virus	Excellent	Poor to Fair (adenovirus resistance)	Poor
DBPs?	Yes (THMs, HAAs)	No	No

Chemical-free treatment opportunities

- Membrane filtration
  - Chemical free solids removal, including protozoa
  - Viruses may pass through
  - Dissolved substances like natural organics pass through
- Ultraviolet light disinfection
  - Chemical free disinfection
  - Certain viruses resistant
  - Need for secondary disinfection?



Approaches to Disinfection Byproduct Regulation – Broad / Narrow



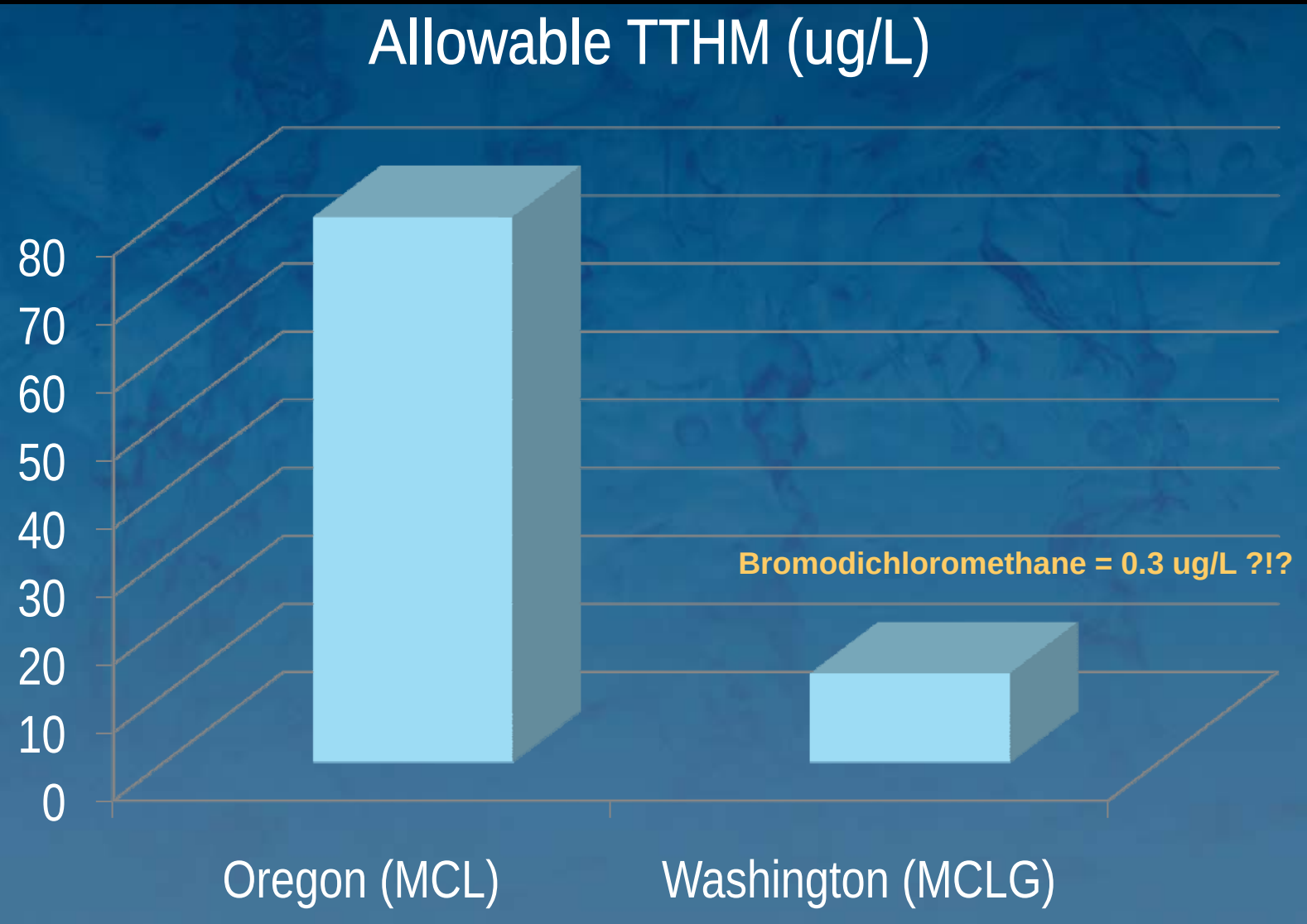
Oregon similar to EPA

- Maximum Contaminant Levels (MCLs)
- Groups of contaminants
- SDWA treatment techniques

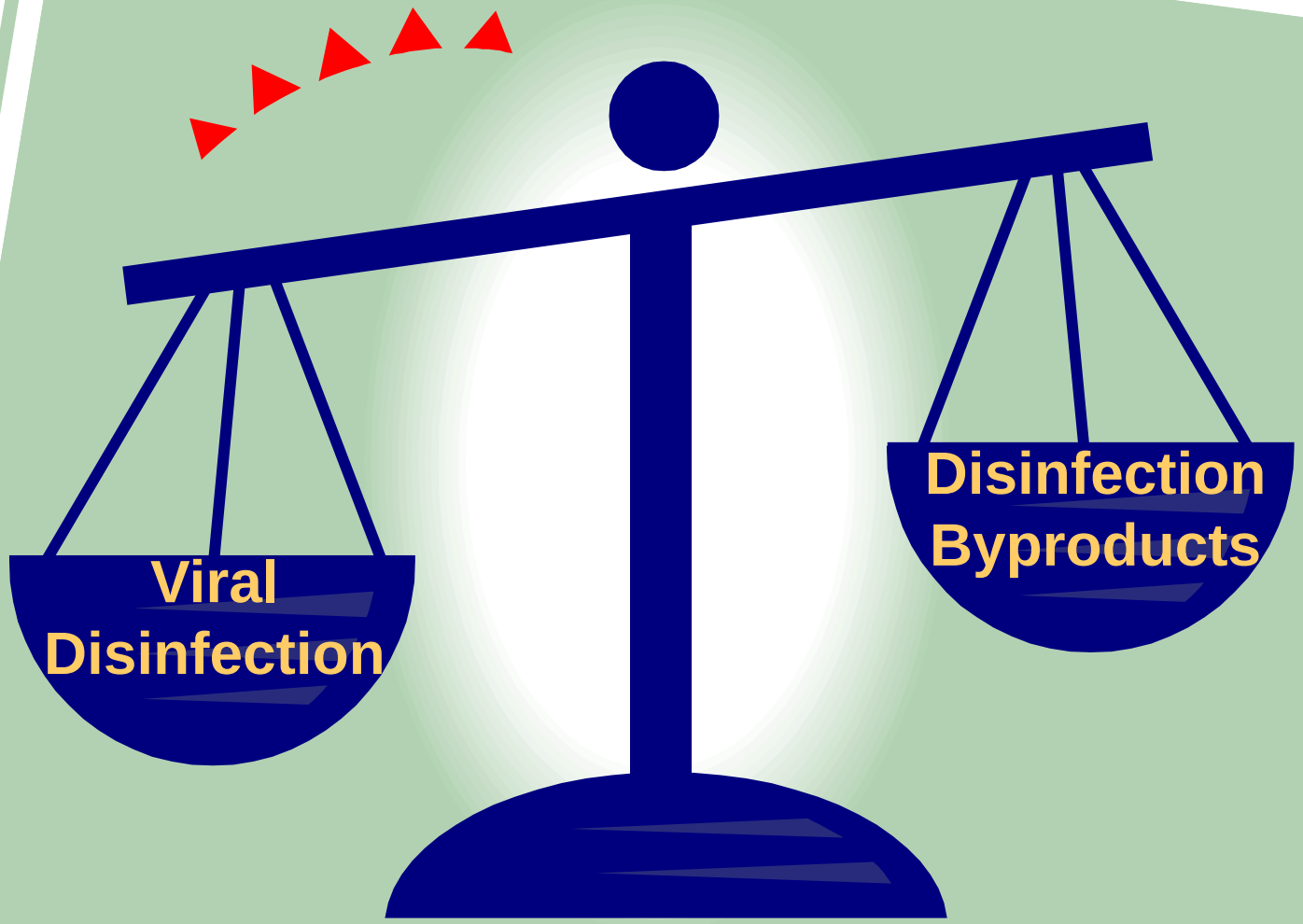
Washington

- Maximum Contaminant Level Goals (MCLGs)
- Specific contaminants
- No SDWA treatment techniques

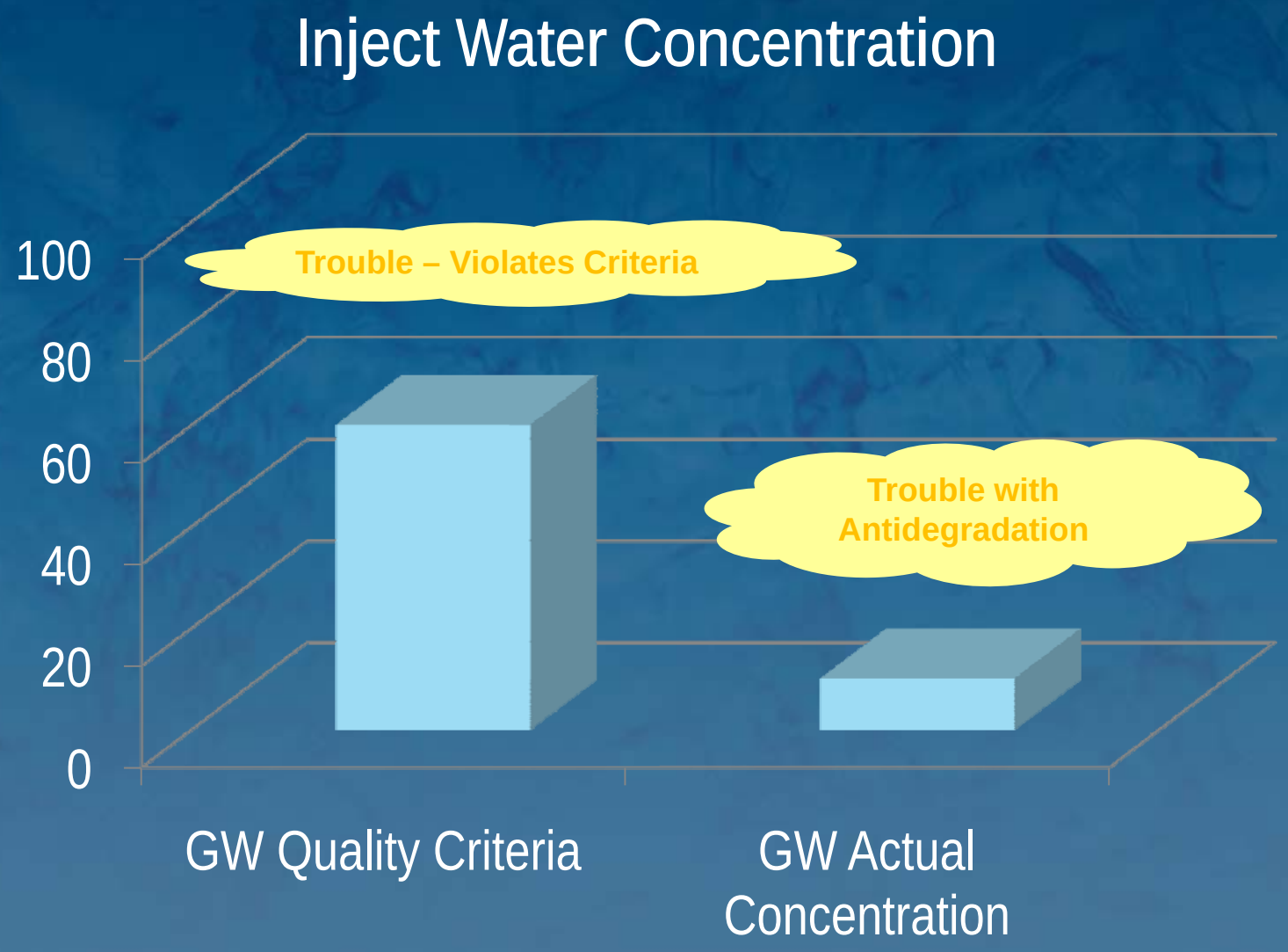
Chlorination / Viral Disinfection Not Feasible in Washington?



Disinfection / DBP balance in Washington



Washington antidegradation clause can set lower limits



Some ASR Projects Underway

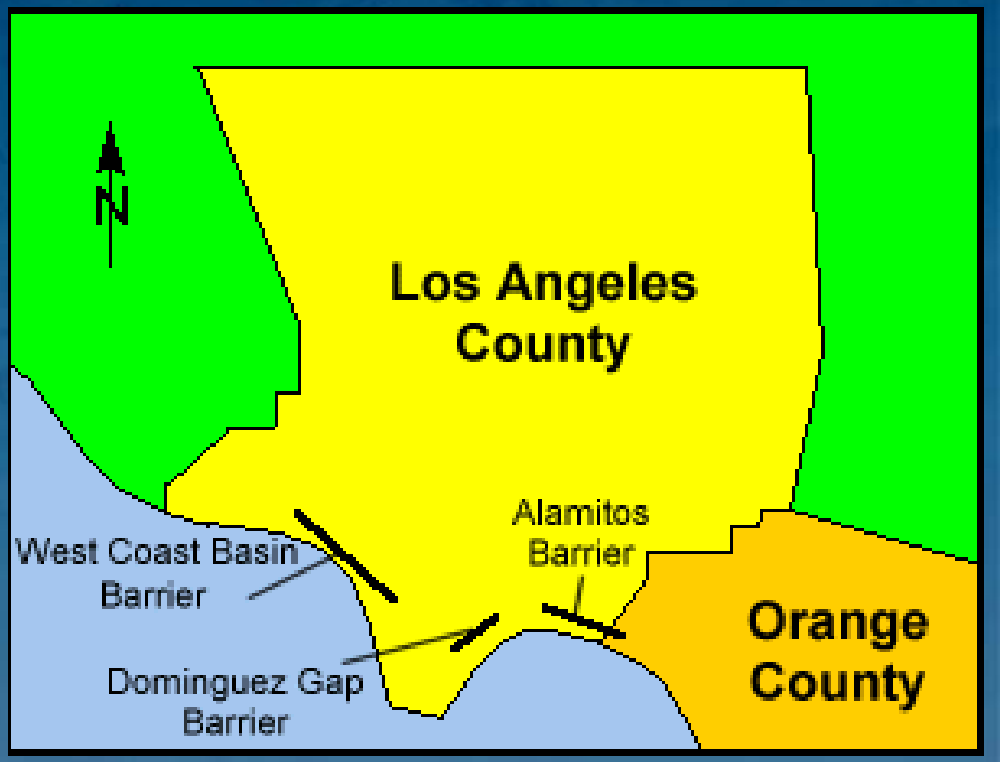
- Oregon
  - Beaverton /
  - Salem
  - Baker City
  - Umatilla

HDR assisted Durango, CO with treating wildfire runoff

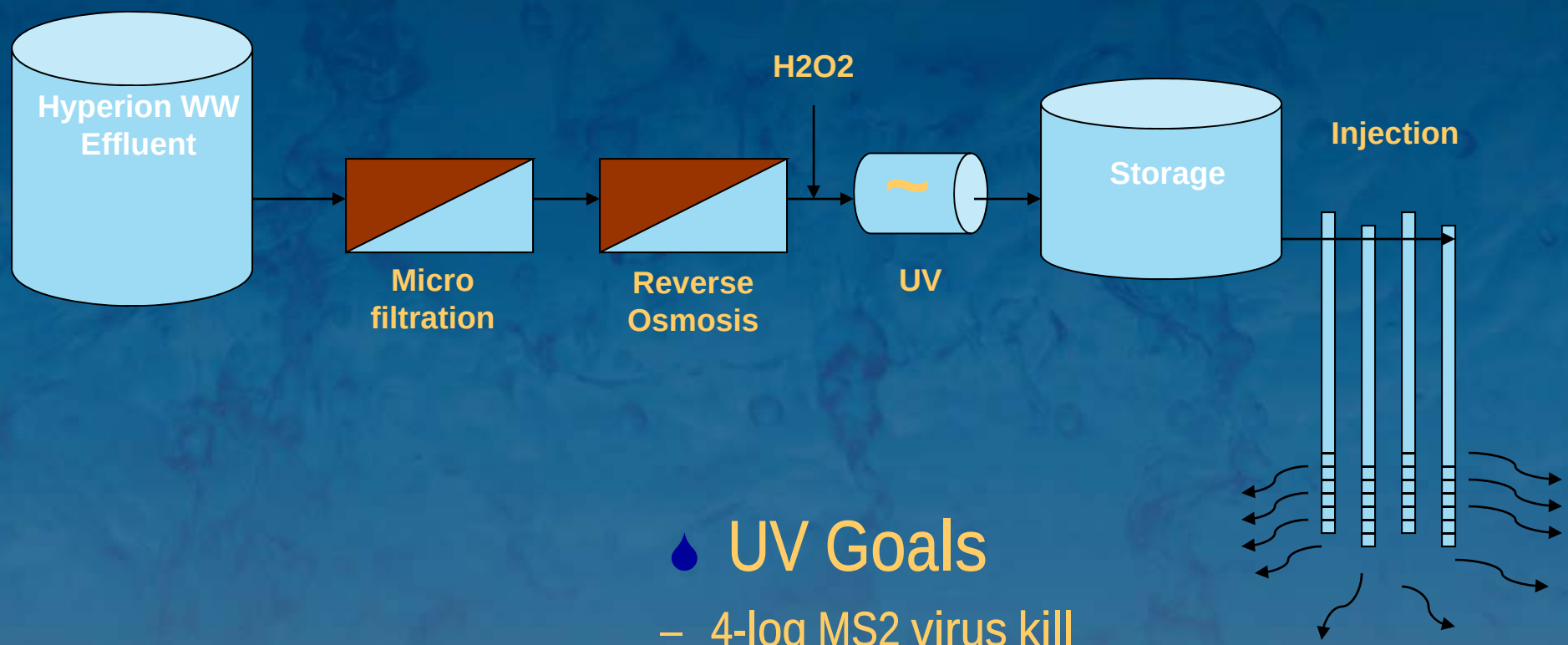
- Washington
  - **Kennewick**
  - Walla Walla
  - Boise White Paper, LLC (Wallula, WA)

California injection program

- Prevent Seawater Intrusion
- Started in 1953 with surface water
- Now 153 wells, 9 miles
- Recycled wastewater injection started 1995



West Basin CA Flow Schematic (when CA still had $)



- UV Goals
  - 4-log MS2 virus kill
  - 1.3-log NDMA destruction
  - Advanced oxidation with hydrogen peroxide

- Wastewater Effluent Source
- Submerged Microfilter Basins

- Reverse Osmosis

TROJAN UV PHOX

UV EFFLUENT

Conclusions / Recommendations

- ASR is a great / necessary water management tool
- Oregon has ASR regulatory framework more consistent with EPA drinking water rules
- Oregon has more successful ASR program
- Implementation hurdles exist in Washington
- A regulatory summit and re-evaluation of Washington ASR regulations would be useful
- Is a wastewater effluent source on the horizon?

Questions?

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Water treatment objectives and techniques

Turn dissolved into particle:	Pre-oxidation
Turn dissolved into particle:	Coagulation
Make particles bigger:	Flocculation
Remove particles:	Sedimentation/Filtration
Inactivate microbes:	Primary disinfection
Protect finished water:	Secondary disinfection
Prevent tooth decay:	Additives like fluoride

State Regulatory Comparison

	Oregon	Washington
Compliance w/SDWA?	Yes	No
Allowance for DBP Formation	MCL	<< MCL
Contaminants	< 50% MCL	Groundwater Quality Criteria
AKART	No	Yes