Water Reuse in the U.S. – Let's All Get on the Same Page

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Engineers...Working Wonders With Water®

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Today's Agenda

- Reuse 101
  - Reuse in the Water Resources Context
  - The Ways Water can be Reused
  - Trends in Water Reuse
- Water Quality Considerations
  - Trace organic compounds
  - Pathogens
- Direct Potable Reuse
- Resources

Reuse 101

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Much like with your Retirement Planning, A Diverse Portfolio is a Prudent Response

- Integrated Water Resource Planning
  - Surface Water
  - Groundwater
  - Reclaimed Water
  - Stormwater
  - Conservation
  - Drought Response Measures

Reuse in the Water Resources Context

Graphic credit: www.healthywaterways.org

- All water is recycled
  - De facto
  - Intentional
- "New" supply
- Efficiency of existing supply
- One time or continuous
- In the gap between CWA and SDWA

The four ways water can be reused…

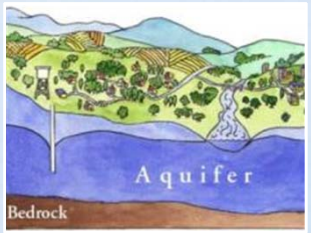
Non-Potable Reuse (NPR) or
“Direct Reuse” (Purple Pipe)

“De Facto”
Potable Reuse

The four ways water can be reused…

Non-Potable Reuse (NPR) or "Direct Reuse" (Purple Pipe)

Indirect Potable Reuse - Surface Water Augmentation



Indirect Potable Reuse - Groundwater Recharge

Direct Potable Reuse

And now, for a little perspective…

…you know what I'm craving?
A little perspective. That's it. I'd like some fresh, clear, well-seasoned perspective. Can you suggest a good wine to go with that?

-Anton Ego (Ratatouille)

In a good water year, everyone gets what they need, and purple pipe system meets non-potable demands

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But when a drought occurs, purple pipe still meeting non-potable demands, but everyone has to cut back on potable demand

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So maybe hybrid approach of some NPR and some IPR makes more sense?

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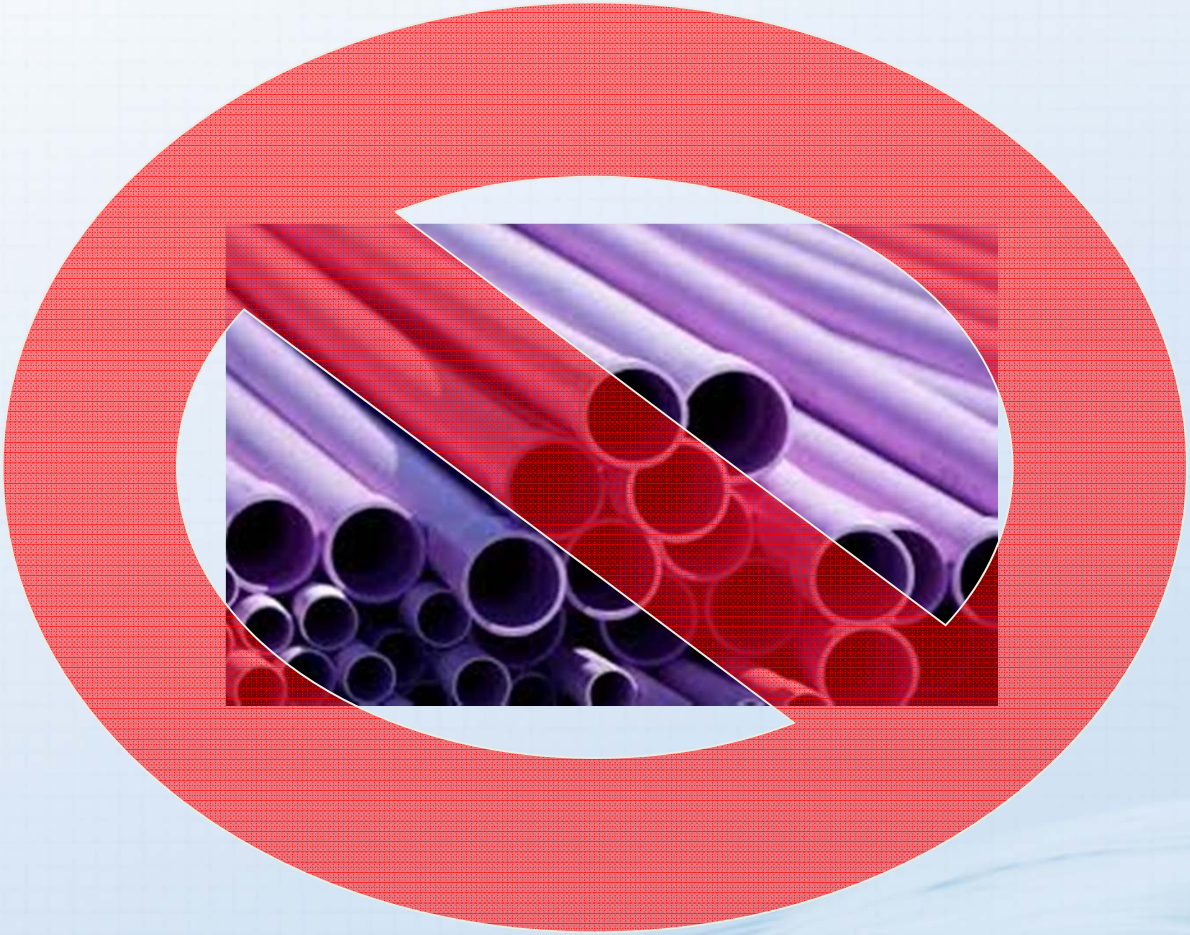
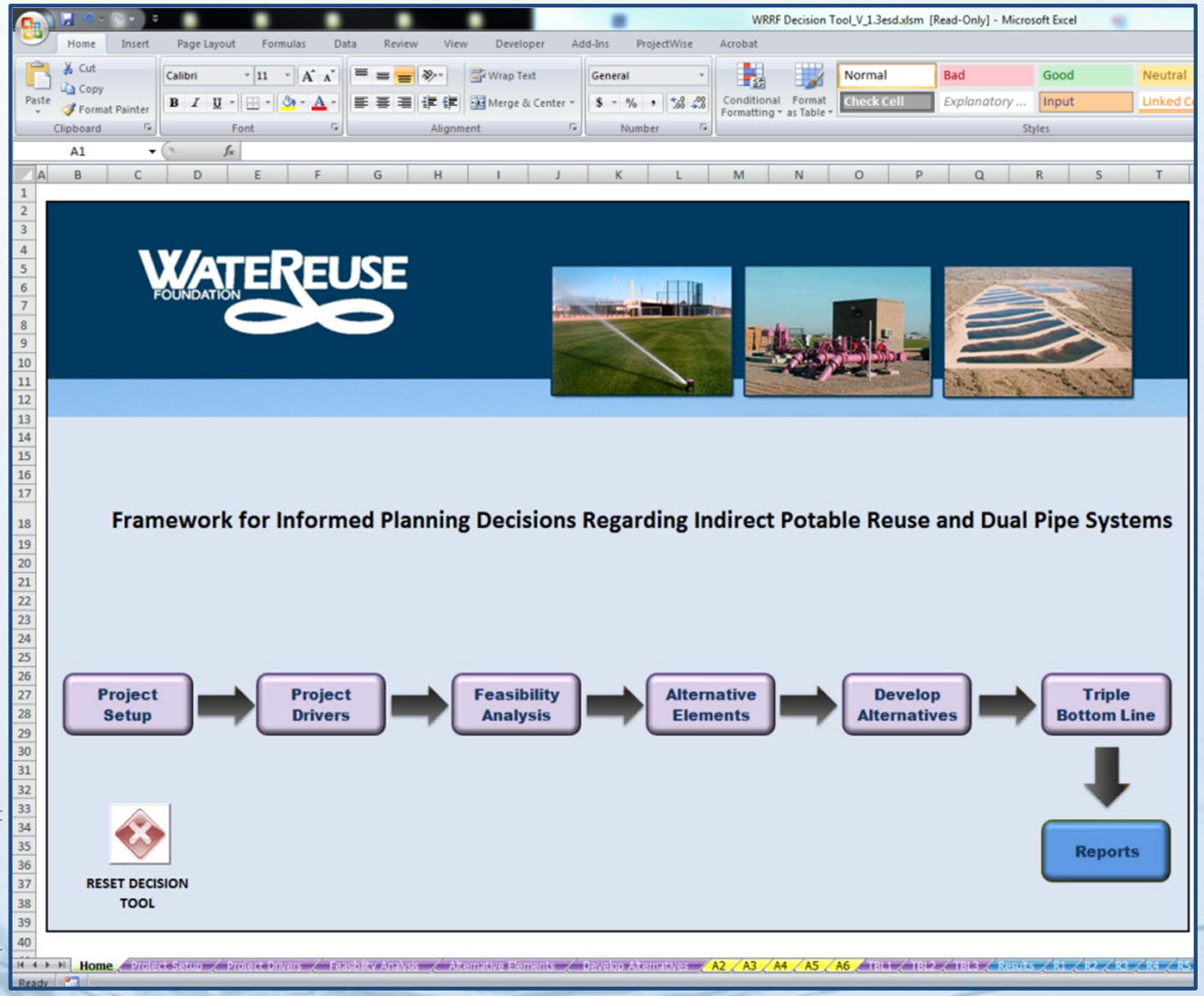


WRRF-09-02: New Decision Tool Helps with Systematic Evaluation



- Easy navigation
- Evaluate up to 6 alternatives per file
- Save file for each evaluation

Trends in Water Reuse

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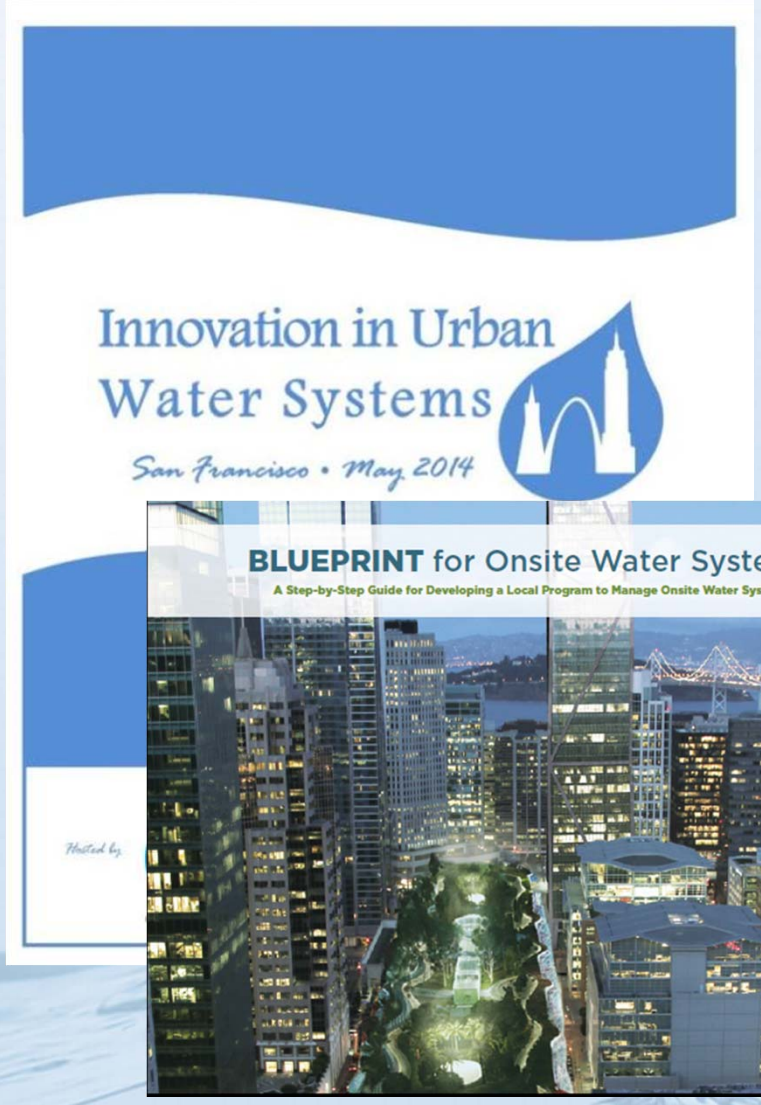
Pushing the Envelope

Trend Toward Decentralized & On-site Water Management

Living Machine in San Francisco Public Utilities Commission Cafeteria Area

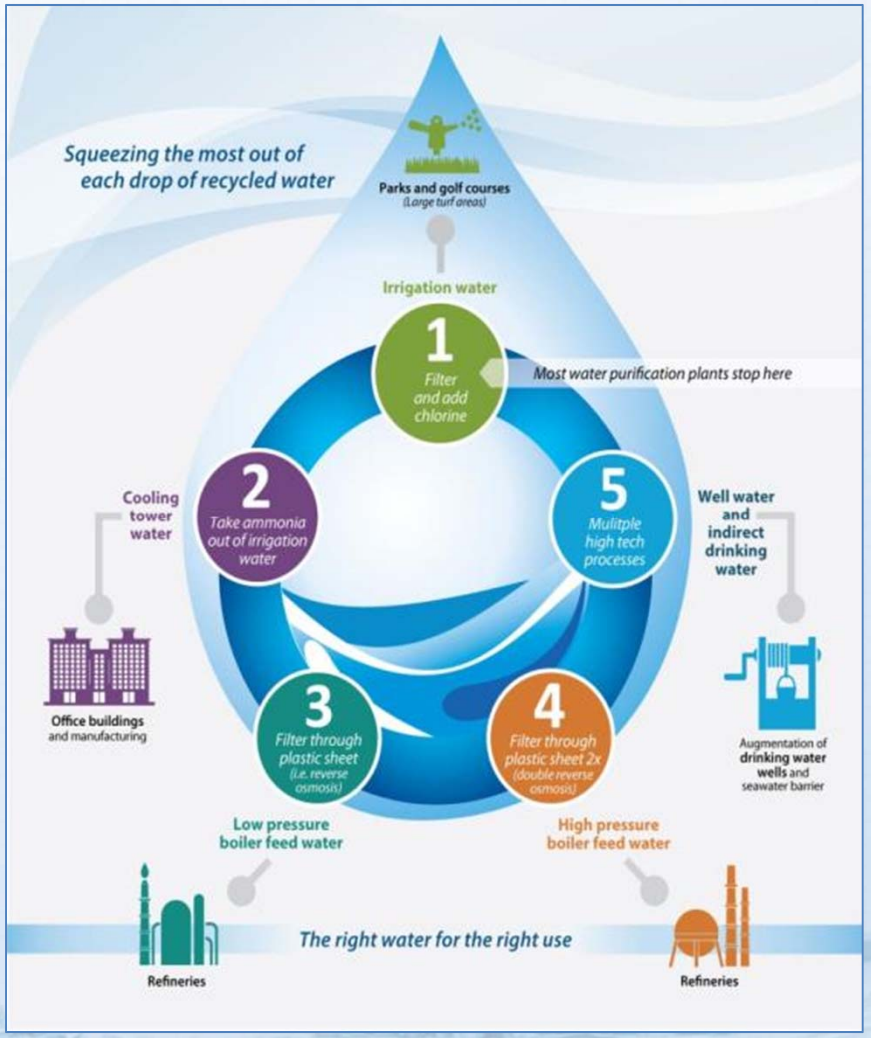


NSF Center: Stanford, Berkeley, Colorado School of Mines

Industrial & Commercial Water Reuse

- Using domestic reclaimed water
  - Mining
  - Power generation
  - Refineries
- Recycling on-site
  - Meat processing
  - Carpet dye house
  - Pharmaceutical & chemical manufacturing
  - Fracking and O&G
  - Thermoelectric power

Designer Water – West Basin, California



- Less costly than importing new water
- 5 qualities of water
  - Irrigation
  - Sans ammonia for cooling towers
  - RO for low pressure boilers
  - 2X RO for high pressure boilers
  - Advanced oxidation for aquifer replenishment

Water Quality Considerations

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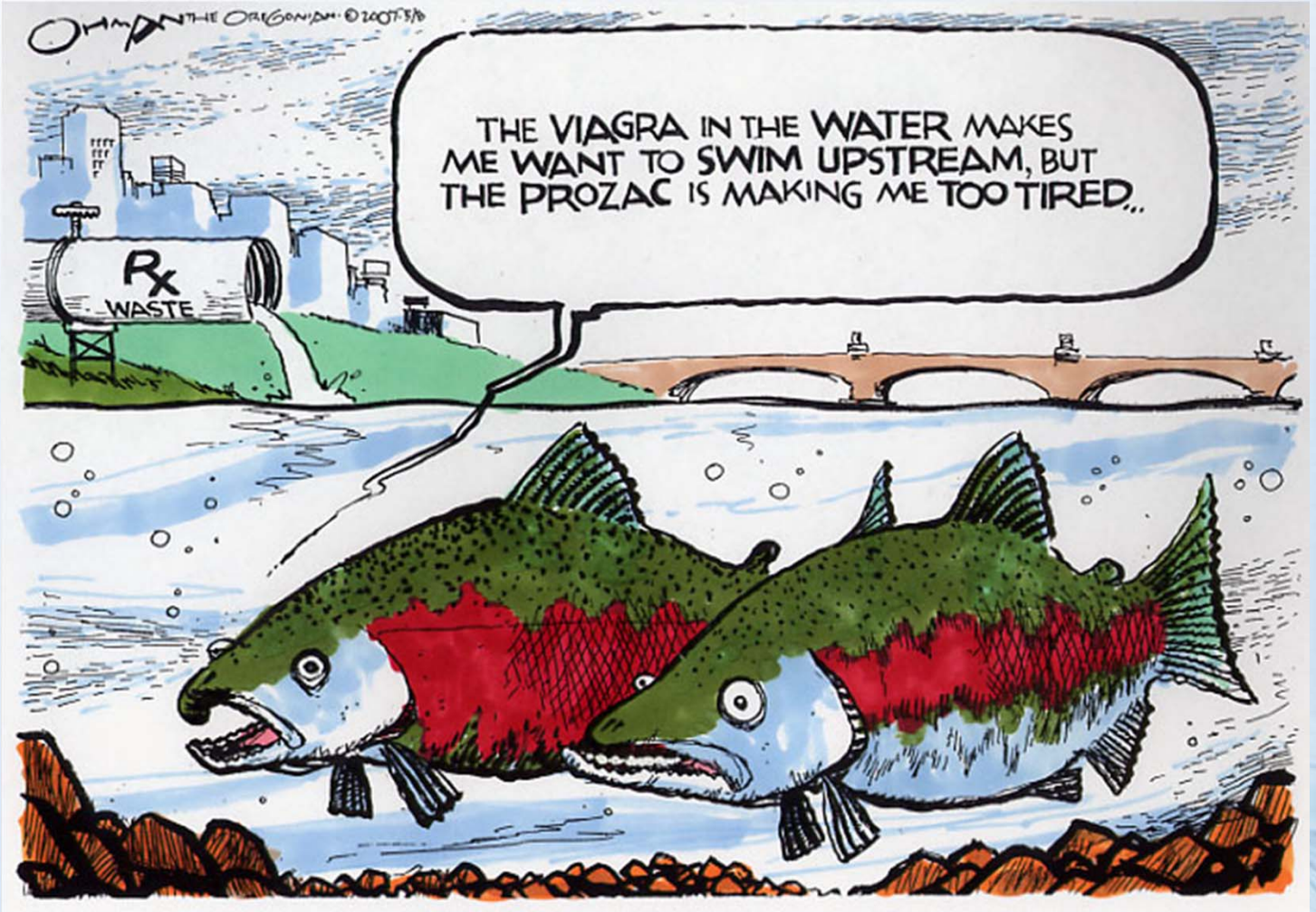
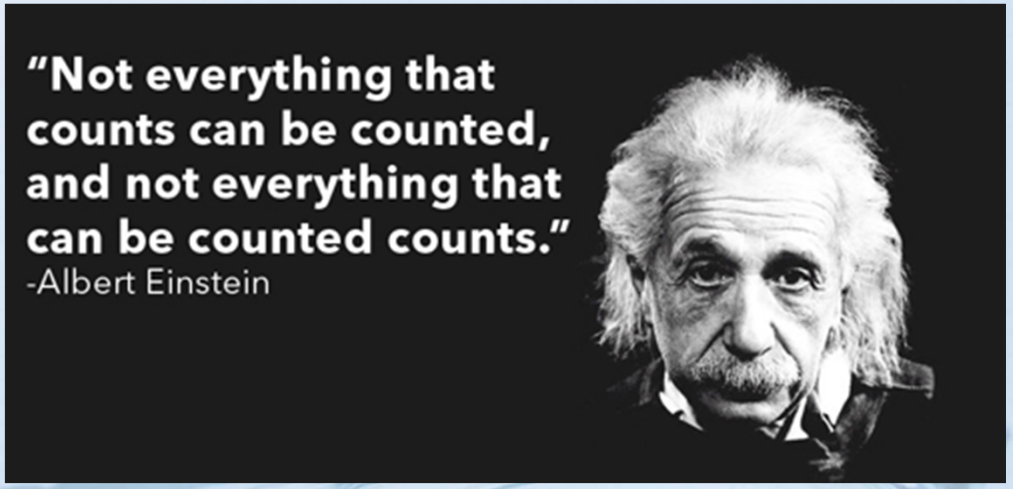
Pharmaceutically Active Compounds



People generally have difficulty with the concept of relative concentrations and risk

- There is a concern that “presence” in any amount is a problem
- Adverse health effects are presumed if anything can be detected.
- There is no “zero” of anything… including risk.



Amount of Water to Meet Acceptable Daily Intake (for Humans) - Pharmaceuticals

	ADI-DWEL	Maximum Water Conc. Finished	Amount of water to meet ADI		
	µg/L	µg/L	8 oz Glasses/d	Gallons/d	55-Gallon drums/d
Atenolol	70	0.026	22,800	1,400	25
Carbamazepine	12	0.018	5,500	340	6.2
Diazepam	35	0.00033	890,000	55,000	1,000
Fluoxetine	35	0.00082	360,000	22,000	400
Gemfibrozil	45	0.0021	180,000	11,000	200
Meprobamate	260	0.043	51,000	3,200	58
Phenytoin	6.8	0.032	1,800	110	2.0
Risperidone	0.49	0.00034	12,000	770	14
Sulfamethoxazole	18,000	0.0030	51,000,000	3,200,000	58,000
Triclosan	2,600	0.0012	19,000,000	1,200,000	22,000

Credit: Shane Snyder, University of Arizona

Cost Implications of Deciding to Reduce Trace Organic Compound Concentrations for a 10 MGD Treatment Plant (add to end of existing process)

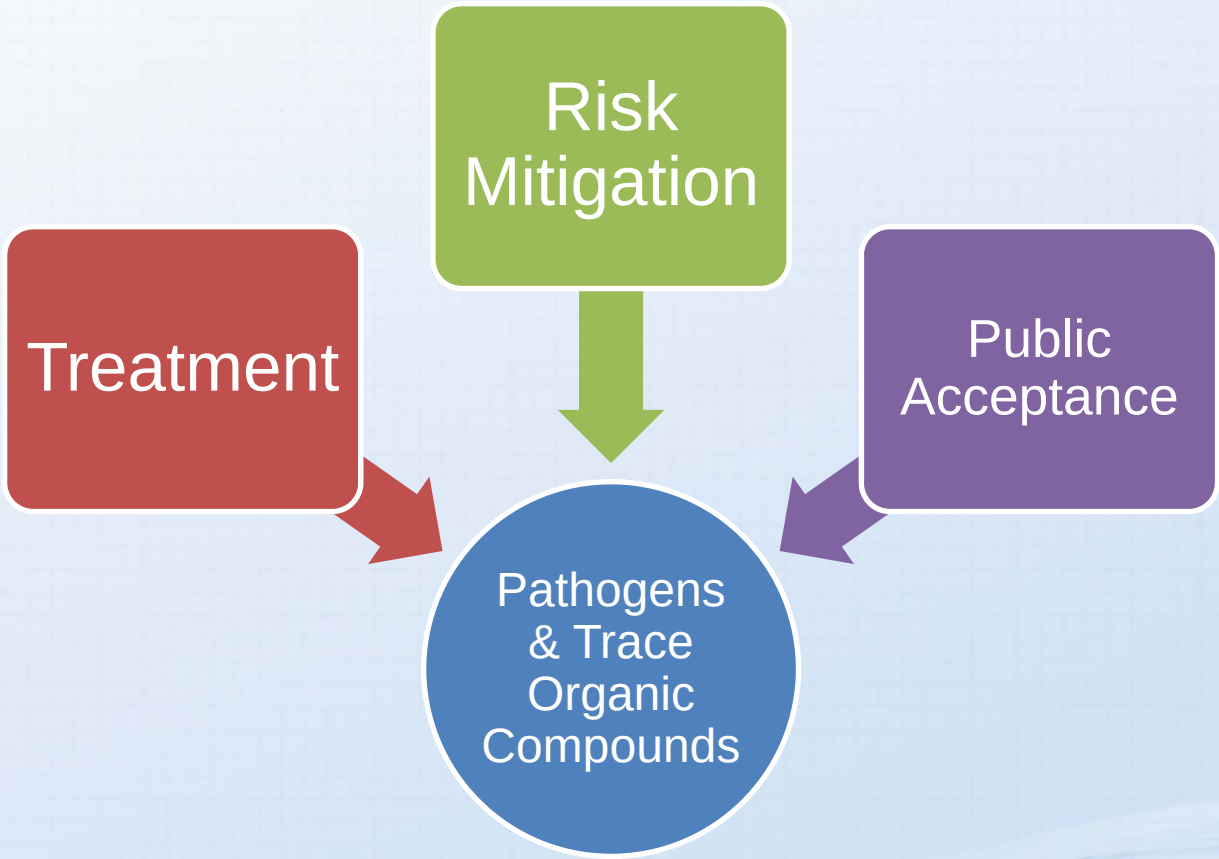
Treatment Technology	Capital Cost	Annual O&M	EEq Destruction
NaOCl (free chlorine residual)	$7,532,000	$219,000	~75%
Medium Pressure UV + Hydrogen Peroxide	$8,923,000	$509,000	>90%
Medium Pressure UV + Peracetic Acid	$9,563,000	$1,645,000	60%
Ozone	$8,828,000	$217,000	>90%
Titanium Dioxide with UV	$15,941,000	$311,000	>90%
MF/RO + UV & H_2O_2	$45,601,000	$2,470,000	>95%

EEq is Estradiol Equivalent; a measure of hormonal activity

But What Keeps Public Health Officials, Engineers, and Operators up at Night?

- Viruses
- Cryptosporidium
- Giardia
- Bacteria

What do you need to do to make drinking water out of sewage?



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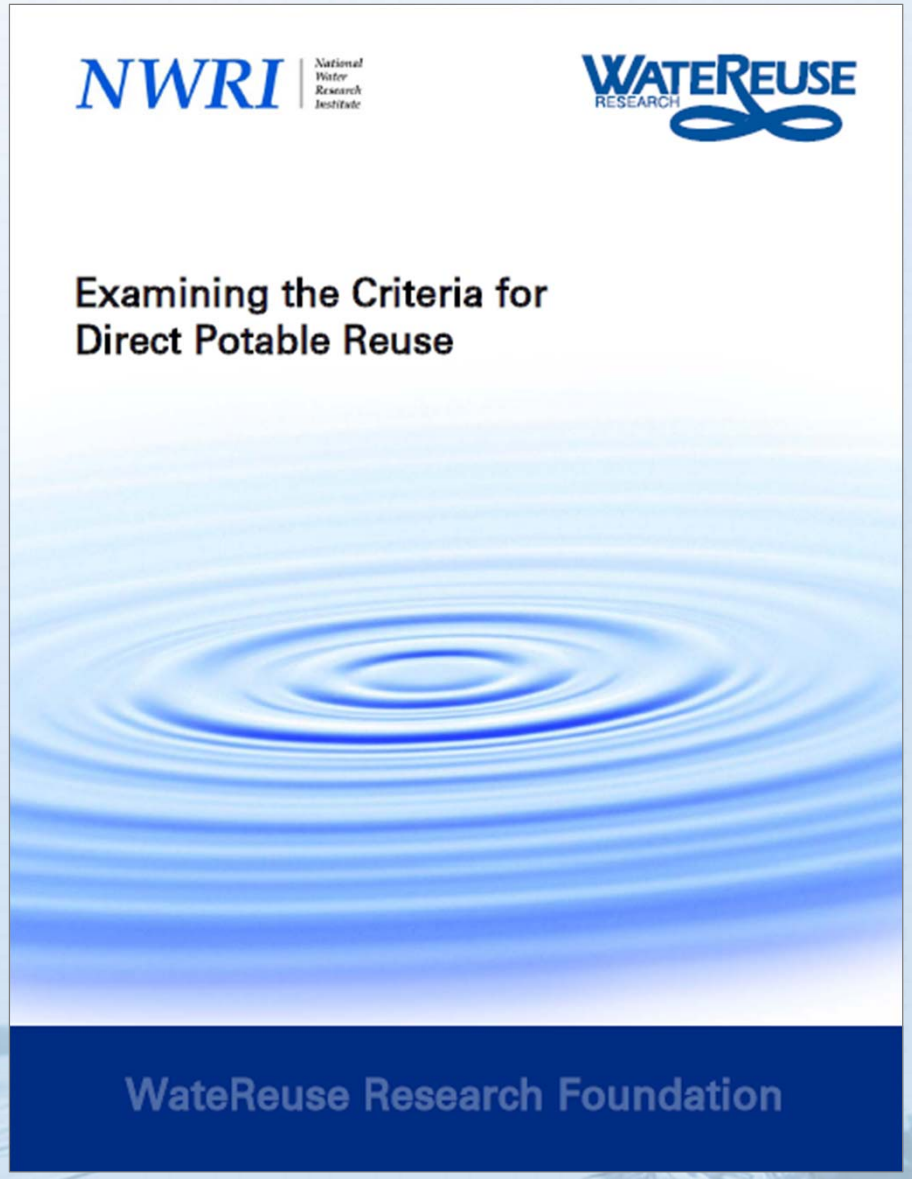
WRRF 11-02 Panel Report specifies treatment goals

- From Raw Wastewater to Potable Water
  - 12-log virus
  - 10-log protozoa (crypto & giardia)
  - 9-log bacteria



NWRI Panel – Chemical Criteria

DBPs	Criterion
THMs	
HAA5	
NDMA	
Bromate	
Chlorate	

Pharmaceuticals	Criterion[a]/If Applicable
Cotinine/Primido Phenyltoin	
Meprobamate/Ate	
Carbamazepine	
Estrone	

Chemicals Relevant to Public Health	Criterion/ If Applicable
PFOA	0.4 µg/L
PFOS	
Perchlorate	
1,4-Dioxane	

Steroid Hormones	Criterion/ If Applicable
Ethinyl Estradiol	None, but if established, it will
17-β-E	

Other Chemicals	
Sucralose	150 mg/L[c]
TCEP	5 µg/L
DEET	200 µg/L
Triclosan	2,100 µg/L

If you address the pathogens, you will address the trace organic chemicals (WRRF-11-02)

Treatment Train	Virus	Crypto	Total Coliform
GOALS From raw wastewater to potable water	**12**	**10**	**9**

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Colorado River Municipal Water District's

Raw Water Production Facility

at Big Spring

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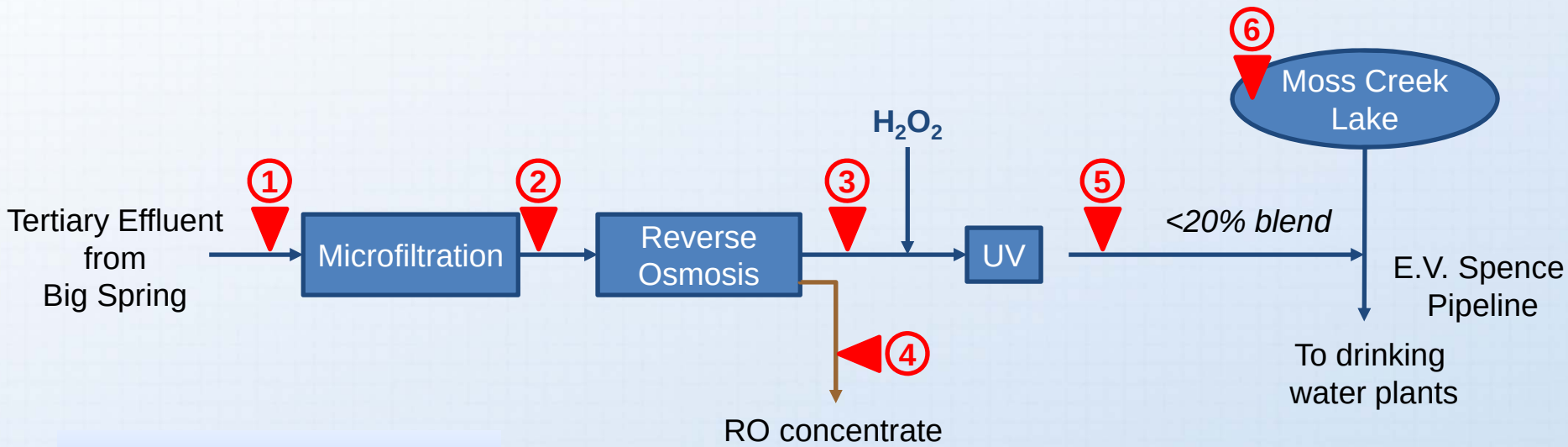
Colorado River Municipal Water District is No Stranger to Drought

- Raw Water Provider
- Serves over 500,000 people in 25 counties
- Relies mainly on surface water reservoirs:
  - Lake J.B. Thomas (44% full)
  - E.V. Spence (<2% full)
  - O.H. Ivie (<15% full)
- Five well fields (peaking)

Lake O.H. Ivie, April 2011

Raw Water Production Facility in Big Spring Provides Supply Diversification



Facility Designed by Freese & Nichols

1 Sample locations

Study Sponsored by:

Texas Water Development Board

WATEREUSE RESEARCH

NWRI

Research Partners:

- *Carollo Engineers*
- *Trussell Technologies*
- *University of Texas*
- *Southern Nevada Water Authority*
- *Nalco Company*
- *Hazen & Sawyer*

Resources

Other Helpful Resources

- EPA Guidelines for Water Reuse
  - 2012 Version: http://www.waterreuseguidelines.org/
- For the Public:
  - www.athirstyplanet.com
  - Ways of Water
- For Technical Info:
  - http://www.watereuse.org/information-resources/reuse/resources
  - http://www.watereuse.org/catalog/foundation-research-reports

Questions/Discussion?

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