The Three Rs of Potable Reuse:

Research, Risks, and Regs

Rocky Mountain Water Reuse Workshop

Golden, Colorado | August 14, 2014

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carollo

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Drivers for Potable Reuse in Colorado and the West

Risks: What's the Big Deal?

Regs: Where are We Headed?

Research: Bridging the Gaps

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Cultural Shifts are Happening in the Water Industry and in Our Communities

"WASTEWATER TREATMENT"

"WATER RECLAMATION" AND "RESOURCE RECOVERY"

Why is POTABLE Reuse Attractive Here?

Direct potable reuse

IPR – Groundwater augmentation

IPR – Surface water augmentation

Year-round

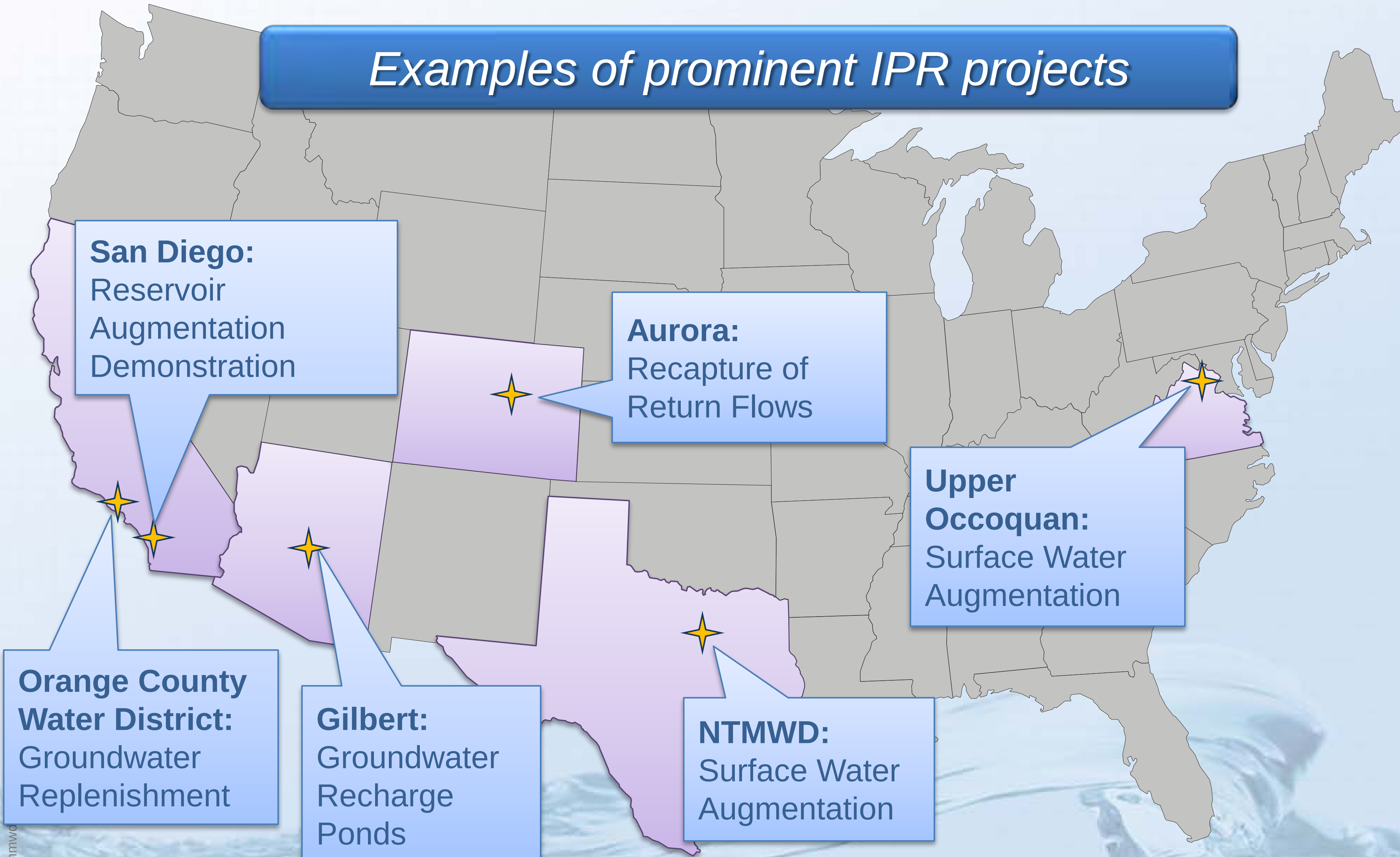
Other nonpotable uses

Year-round

Landscape Irrigation

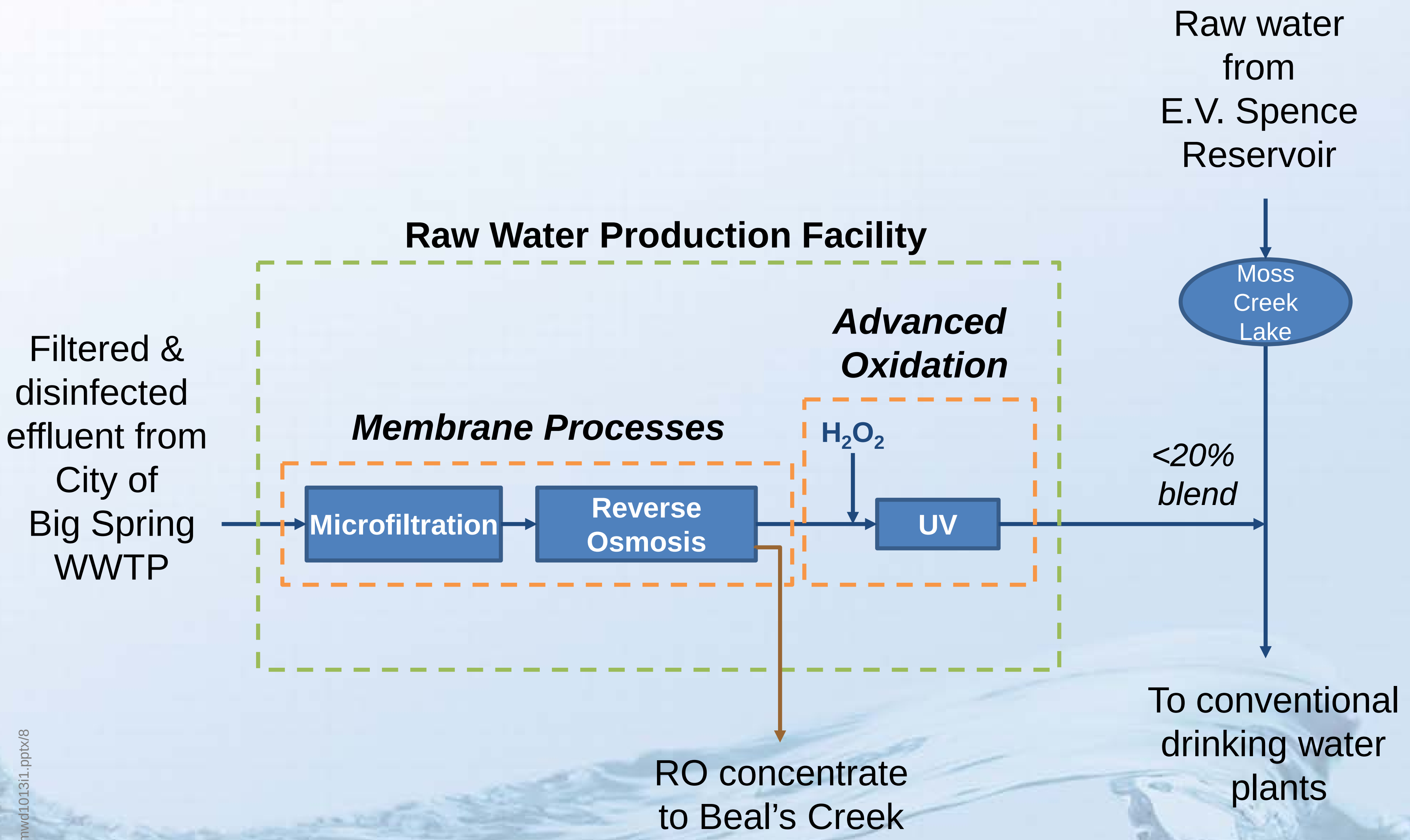
Seasonal

IPR has Essentially Become Commonplace



DPR is Getting "Closer to Home"

“Raw Water Production Facility” in Big Spring, TX



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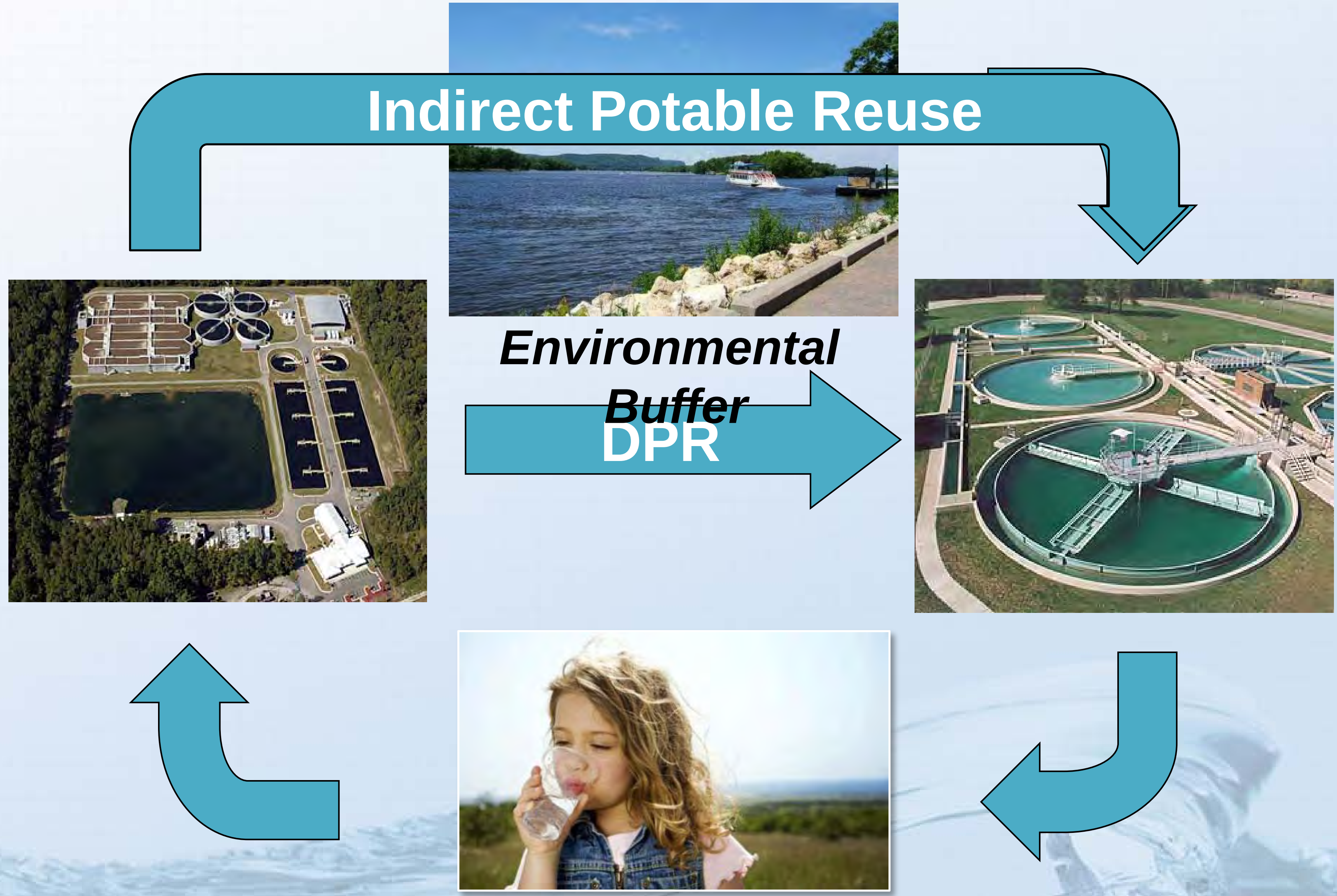
- Drivers for Potable Reuse in Colorado and the West
- **Risks: What's the Big Deal?**
- Regs: Where are We Headed?
- Research: Bridging the Gaps

Potable Reuse



National Research Council

"Water Reuse, Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater", 2012

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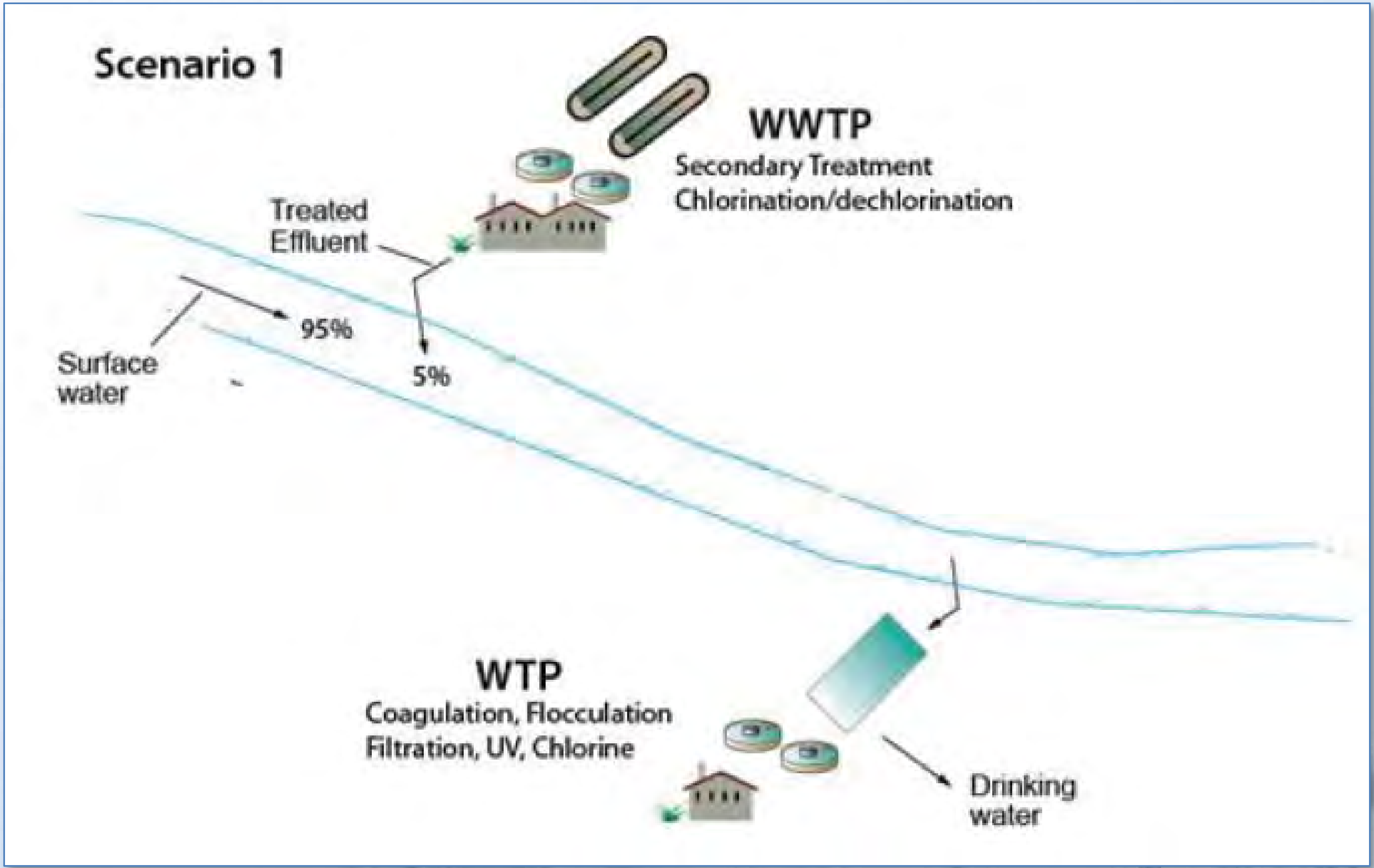
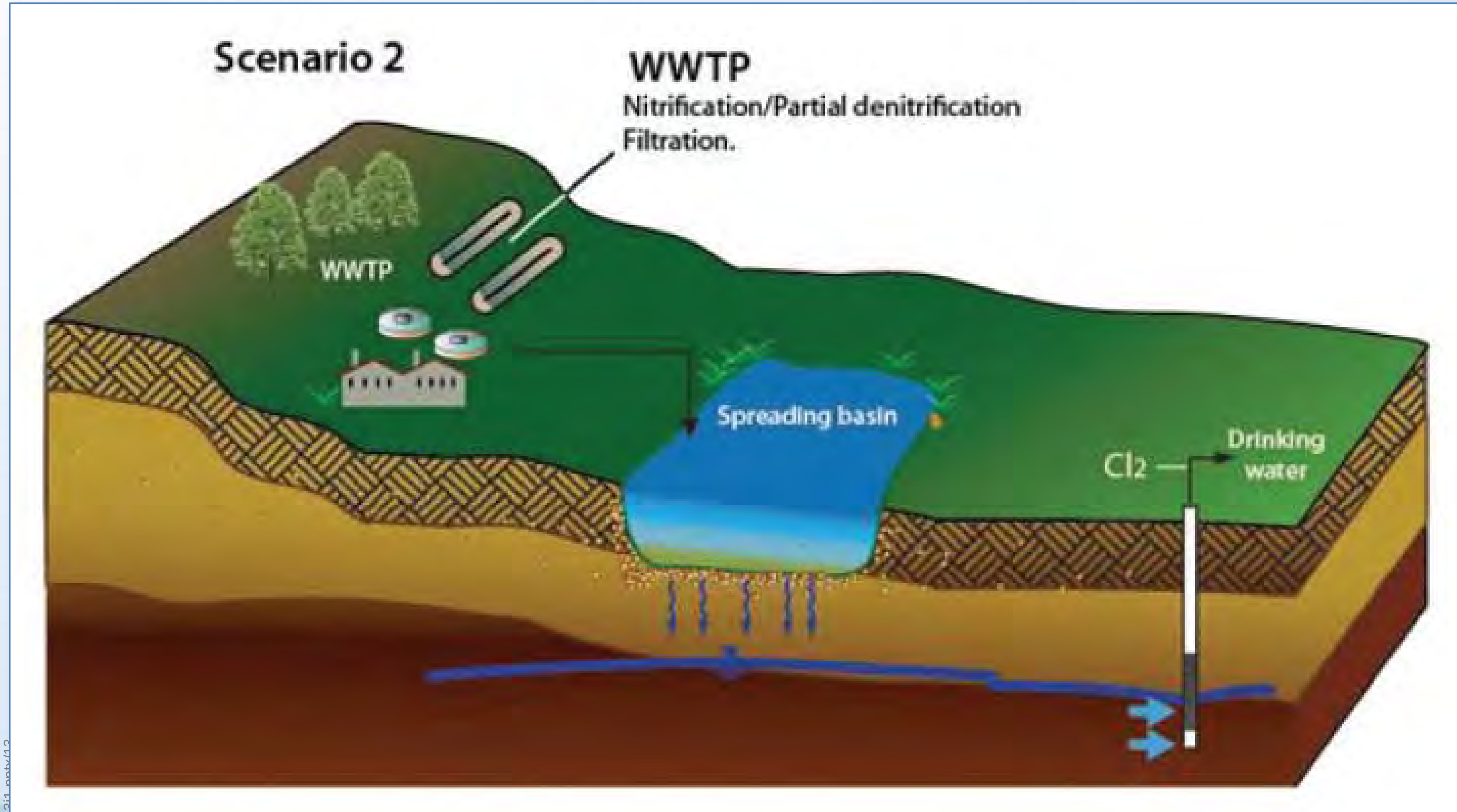
Three risk scenarios examined



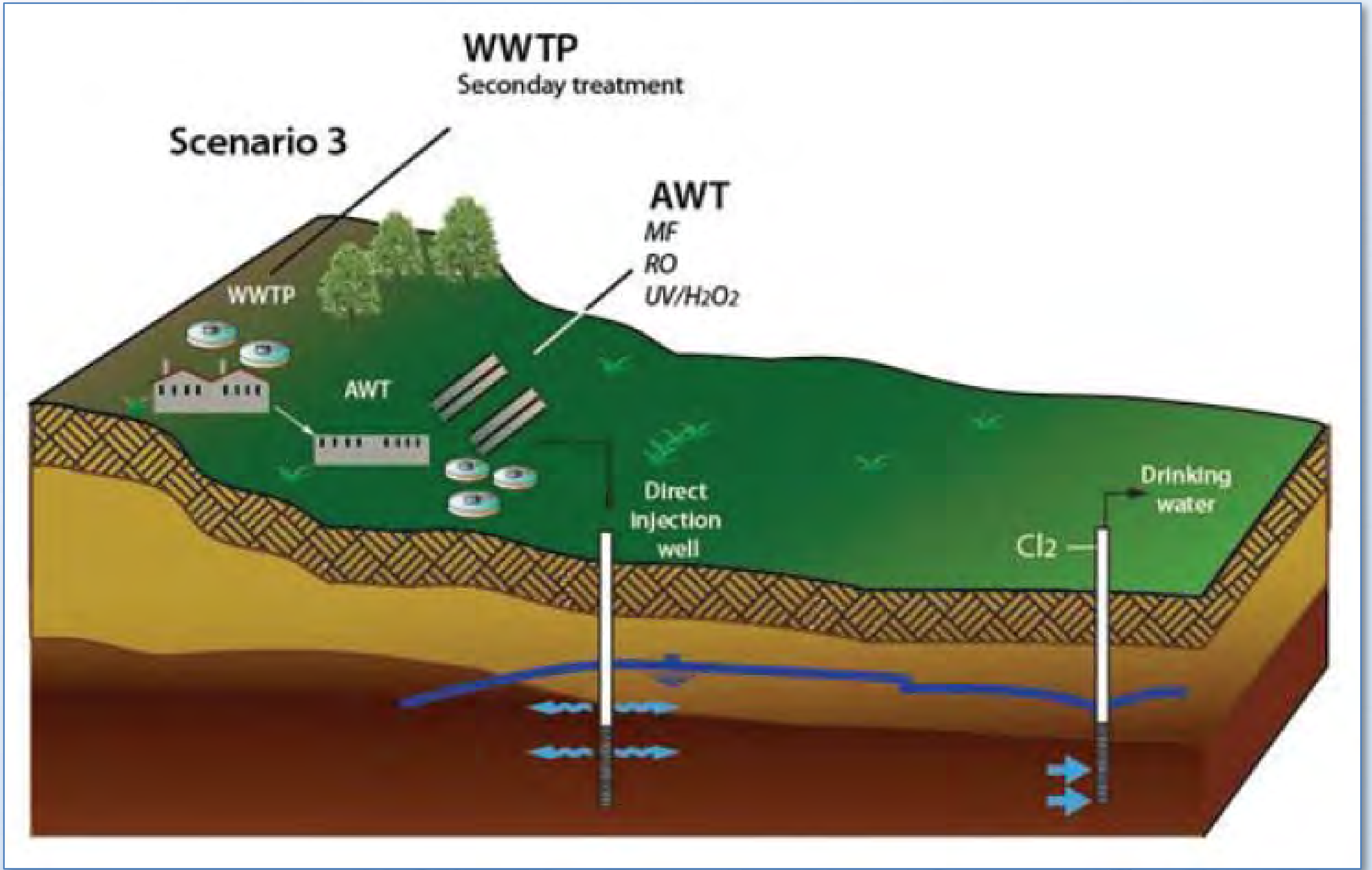
NRC 2012

Three risk scenarios examined



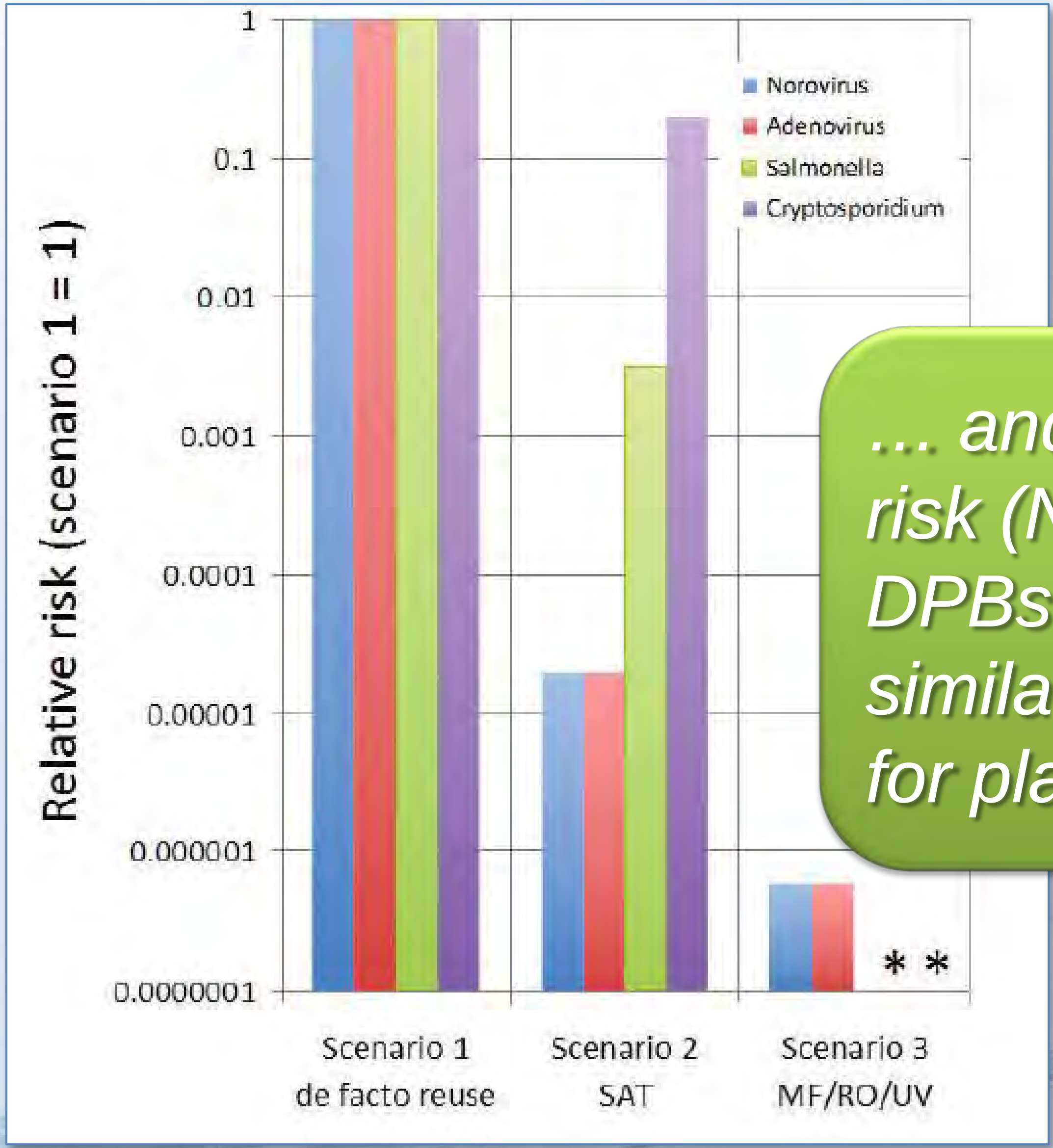
NRC 2012

Three risk scenarios examined



NRC 2012

Pathogen risk lowest for planned IPR



.... and chemical risk (NDMA, DPBs, etc.) was similar or lower for planned IPR

NRC 2012

GOING FROM INDIRECT TO DIRECT POTABLE REUSE

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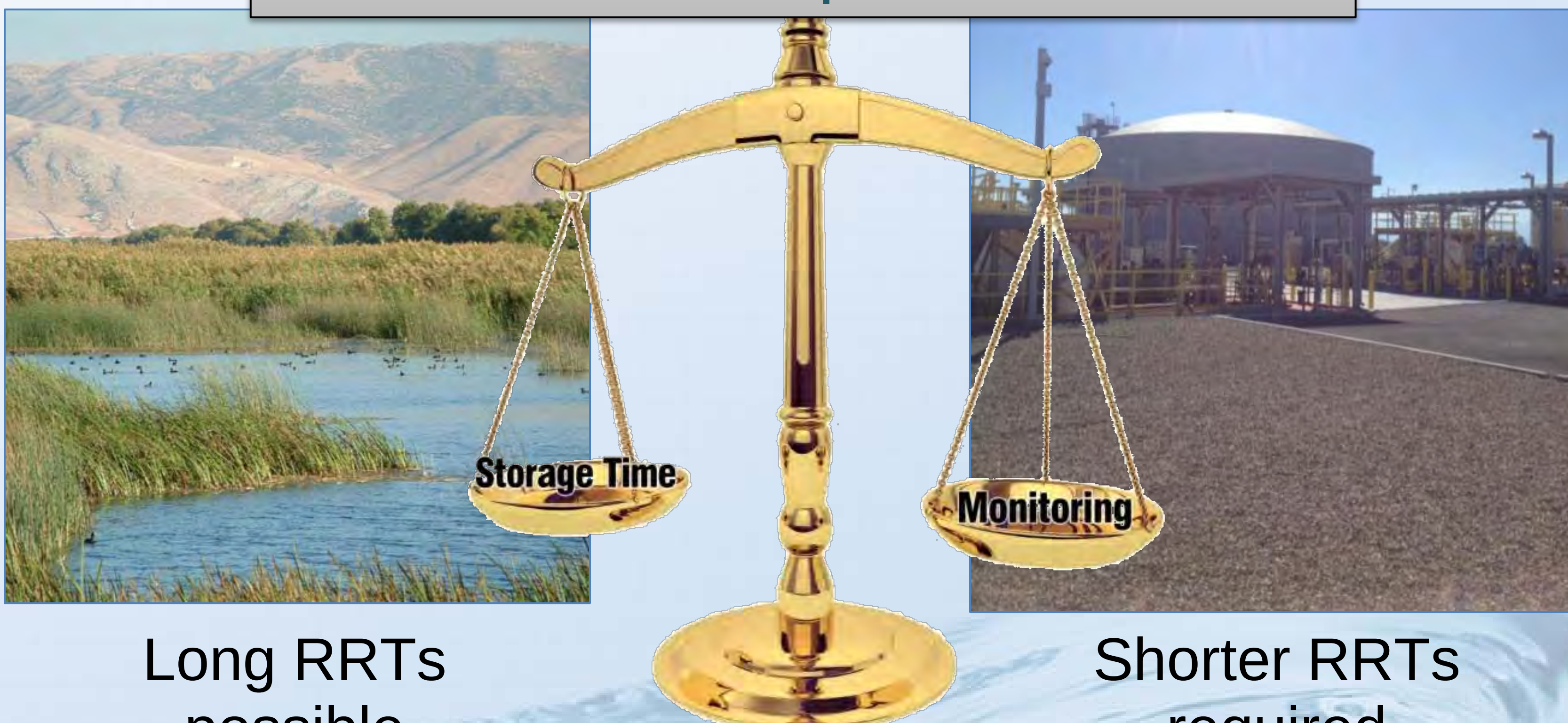
IPR vs. DPR:
Natural vs. engineered buffers

Response Retention Time (RRT)

Treatment

Perception



Long RRTs possible (months)

Shorter RRTs required (hours – days)

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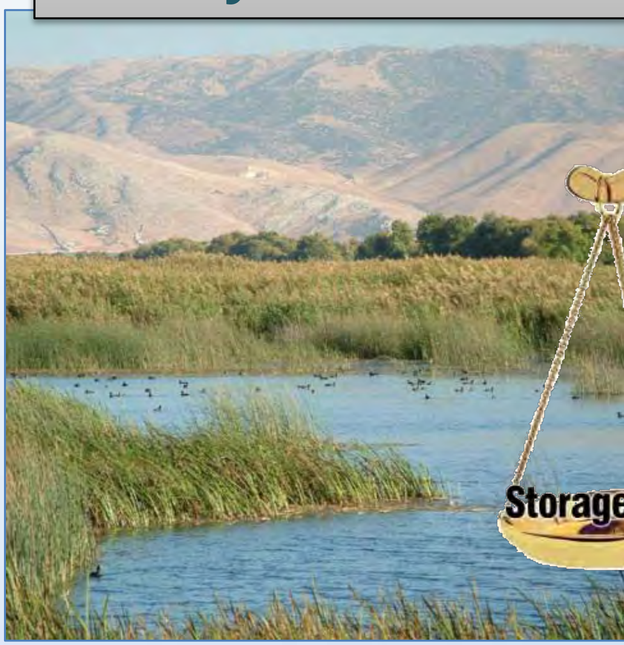
How do we Compensate for Reduced RRT?

Additional monitoring and/or
Additional (redundant) treatment
-- anywhere along the overall treatment train --



Long RRTs possible (months)

Shorter RRTs required (hours – days)

Problem Statement -
Different ways to ask the same question:

- How does DPR fit within the current regulatory "gap" between:
  - Wastewater treatment regulations (CWA etc.)
  - Drinking water treatment regulations (SDWA etc.)
- How does DPR fit within the context of existing practices:
  - Indirect potable reuse
  - *de facto* reuse
- ***Or – what must be done to wastewater to transform it into a raw water suitable for potable water treatment?***

Opinions diverge on treatment goals for DPR… or do they?

- California Department of Public Health (IPR):
  - 12-log virus
  - 10-log *Giardia*
  - 10-log *Crypto*
- WateReuse Research Foundation (11-02):
  - 12-log enteric virus
  - 10-log *Crypto* (*Giardia* implied)
  - 9-log bacteria
- Texas: case-by-case
  - Use wastewater <u>effluent</u> as a starting point
  - Baseline requirements:
    - 8- or 9-log virus
    - 6-log *Giardia*
    - 5.5-log *Crypto*

Everyone (in the US) Agrees on the Potable End Goal!

We know that treatment trains can meet those goals

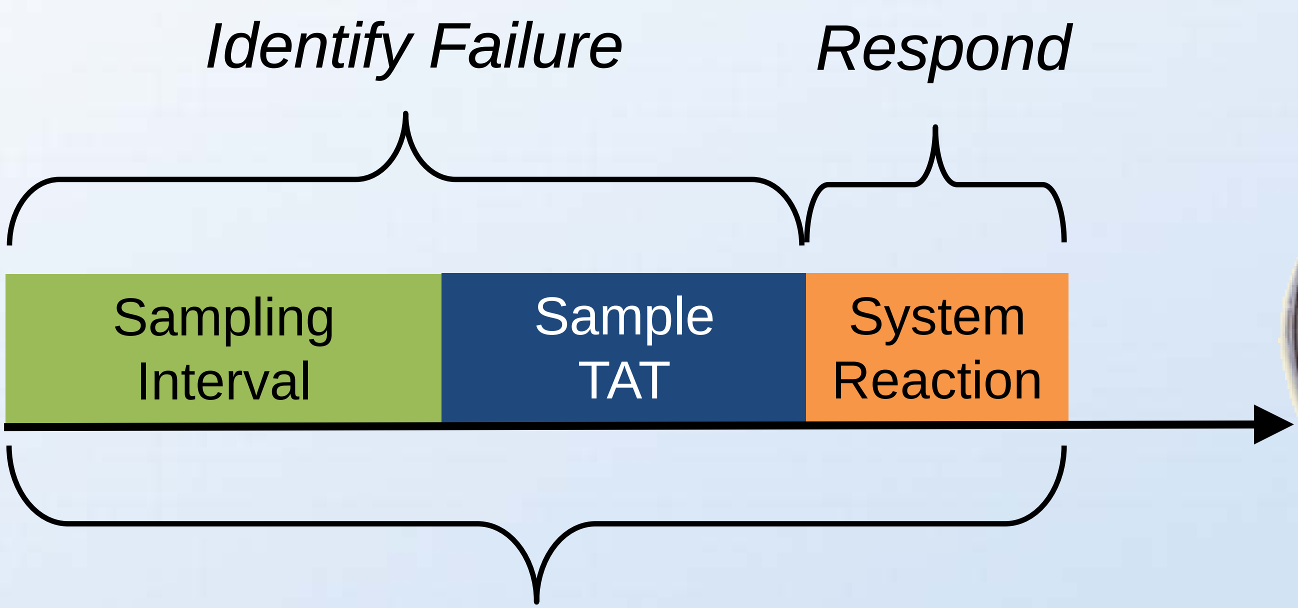
Treatment Train	Virus	Crypto	Total Coliform
CAS → MF → RO → UV/H_2O_2 → Cl_2	15	12	18
CAS → O_3 → MF → RO → UV/H_2O_2	15	13	18
CAS → UF → O_3 → BAF → UV	14	11	16
GOALS	**12**	**10**	**9**

But what if a process fails?

Treatment Train	Virus	Crypto	Total Coliform
CAS → MF → RO → ~~UV/H$_2$O$_2$~~ → Cl$_2$	~~1[illegible]~~ 9	~~1[illegible]~~ 6	~~1[illegible]~~ 12
CAS → O$_3$ → MF → RO → UV/H$_2$O$_2$	15	13	18
CAS → UF → O$_3$ → BAF → UV	14	11	16
GOALS	**12**	**10**	**9**

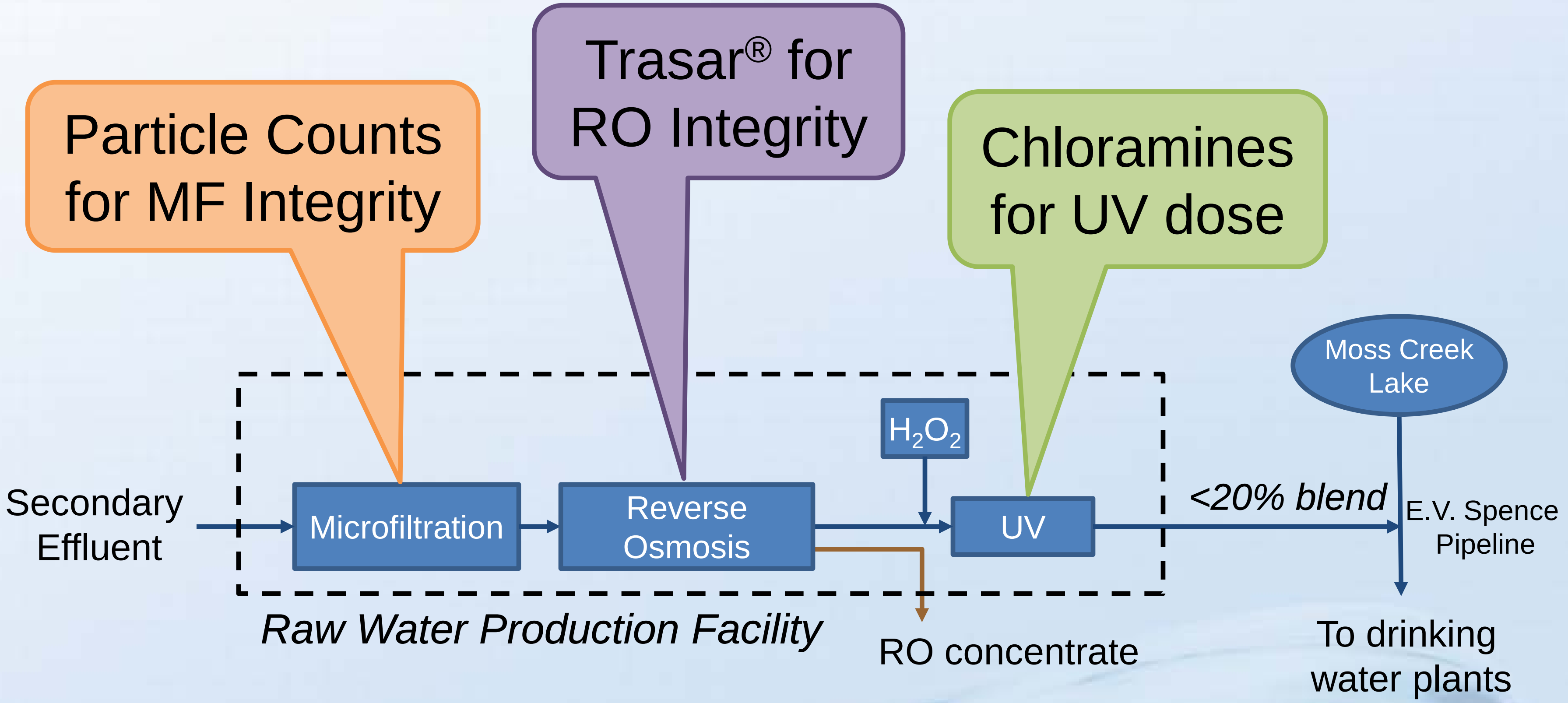
Monitoring technology limits options

Failure Response Time



Failure Response Time (FRT) for <u>one</u> process

Monitoring study at Big Spring will demonstrate some new monitoring tools



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Non-potable Reuse Regs Mitigate Risks In Part by Avoiding Ingestion

Personal Exposure

- Ingestion
- Inhalation
- Dermal contact

Environmental Exposure

- Surface water
- Groundwater

Cross-connections

- Proximity to potable piping
- Access

Potable Reuse Regulations: A Whole New Set of Challenges

Contaminants of Emerging Concern

Reliability

Sensitive Water Supply

Monitoring & Treatment Technologies

CWA + SDWA = IPR ?

~~CWA + SDWA = DPR~~

NWRI-NSF Direct Potable Reuse Treatment Workshop (July 2014):

The CWA and SDWA were not intended to be used for DPR.

IPR Regulatory Approach Options

	Prescriptive	*Performance*
ELEMENTS	• Specify water quality requirements, removal efficiencies • Specify treatment technologies and reliability/ redundancy • Provide process for variances	• Specify water quality requirements • Rely on existing NPDES discharge and SDWA requirement
CONSIDERATIONS	• Confidence in technology and performance • Provides "belt & suspenders" • Doesn't easily accommodate evolving technologies	• Sufficient for "de facto" IPR (unplanned downstream) • Streamlined permitting and enforcement • Typically not geared toward emerging contaminants

California's New Groundwater Replenishment Regs Spell Out Key Requirements

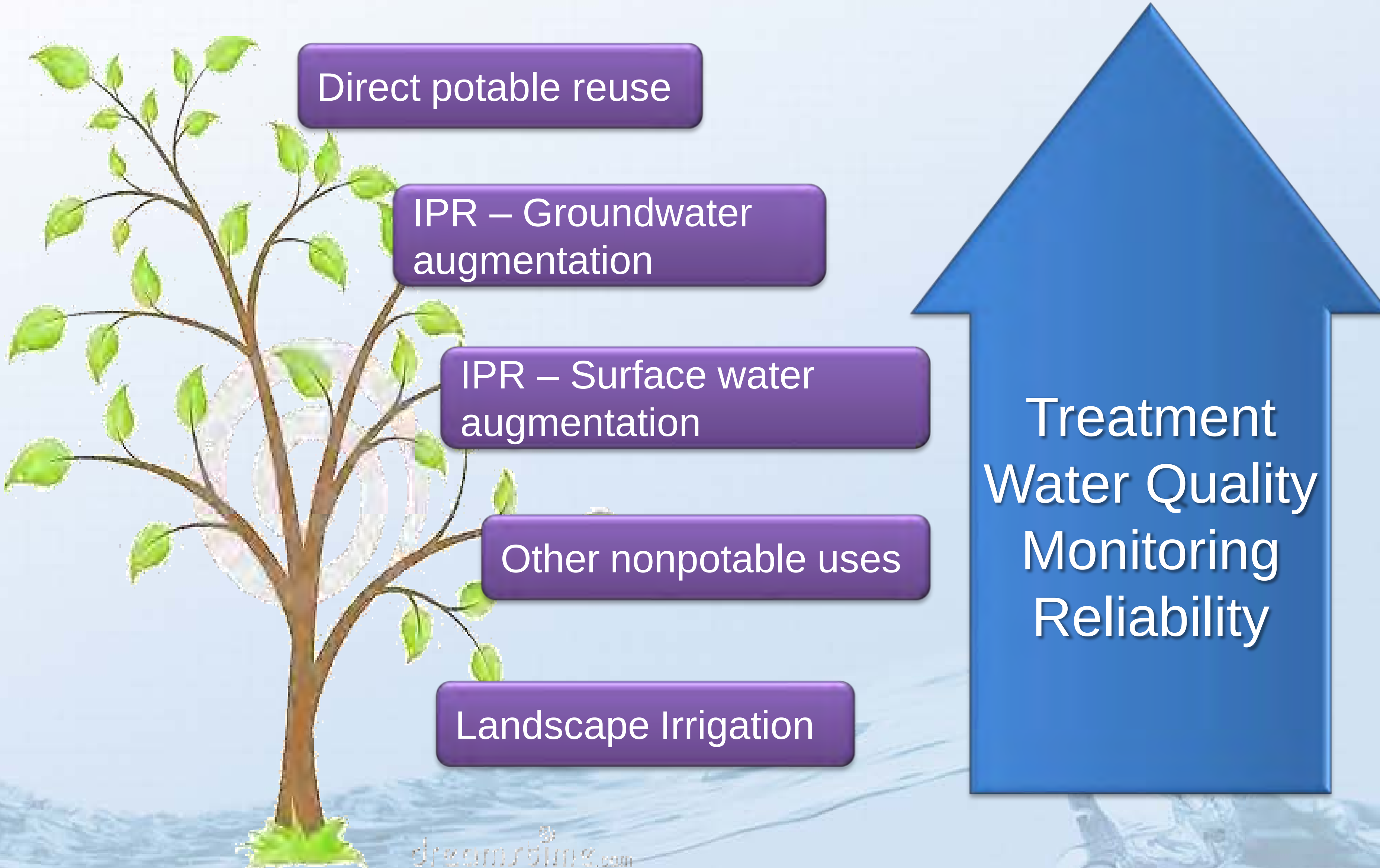
Treatment & Quality

- Filtered, disinfected tertiary water
- 12/10/10 log reduction for enteric virus, Giardia, and Crypto
- Total nitrogen <10 mg/L
- Others < MCL or AL
- RO for injection systems

Requirements and Credits

- <20% recycled water contribution relative to diluent water
- Virus reduction credits for every 1 month in GW storage
- Monitoring wells required

Regulatory Development Reflects Interest and Demand for Reuse



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Caffeine

Ethynyl estradiol

DEET

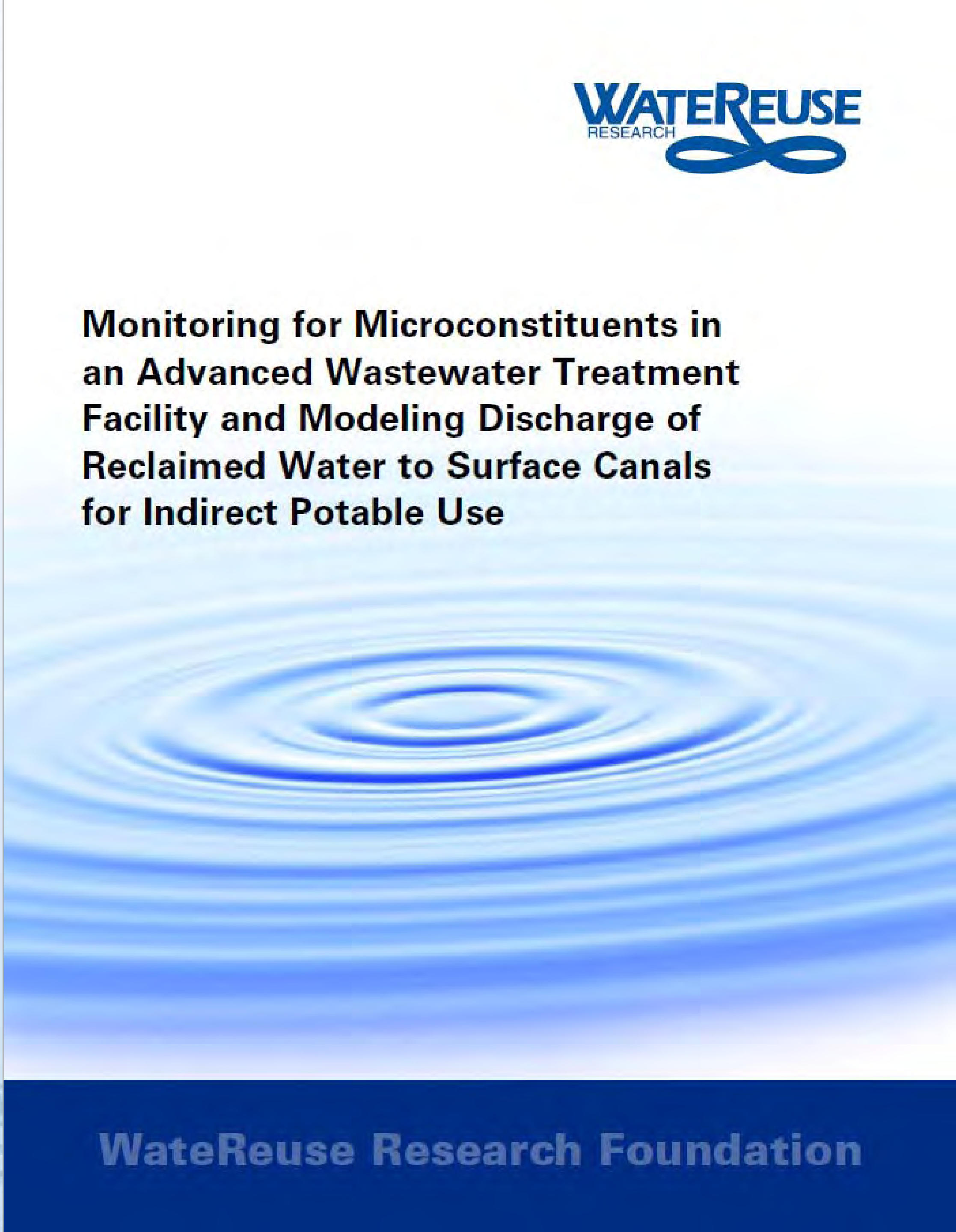
Flame Retardants

Triclosan

Surfactants

Bisphenol-a

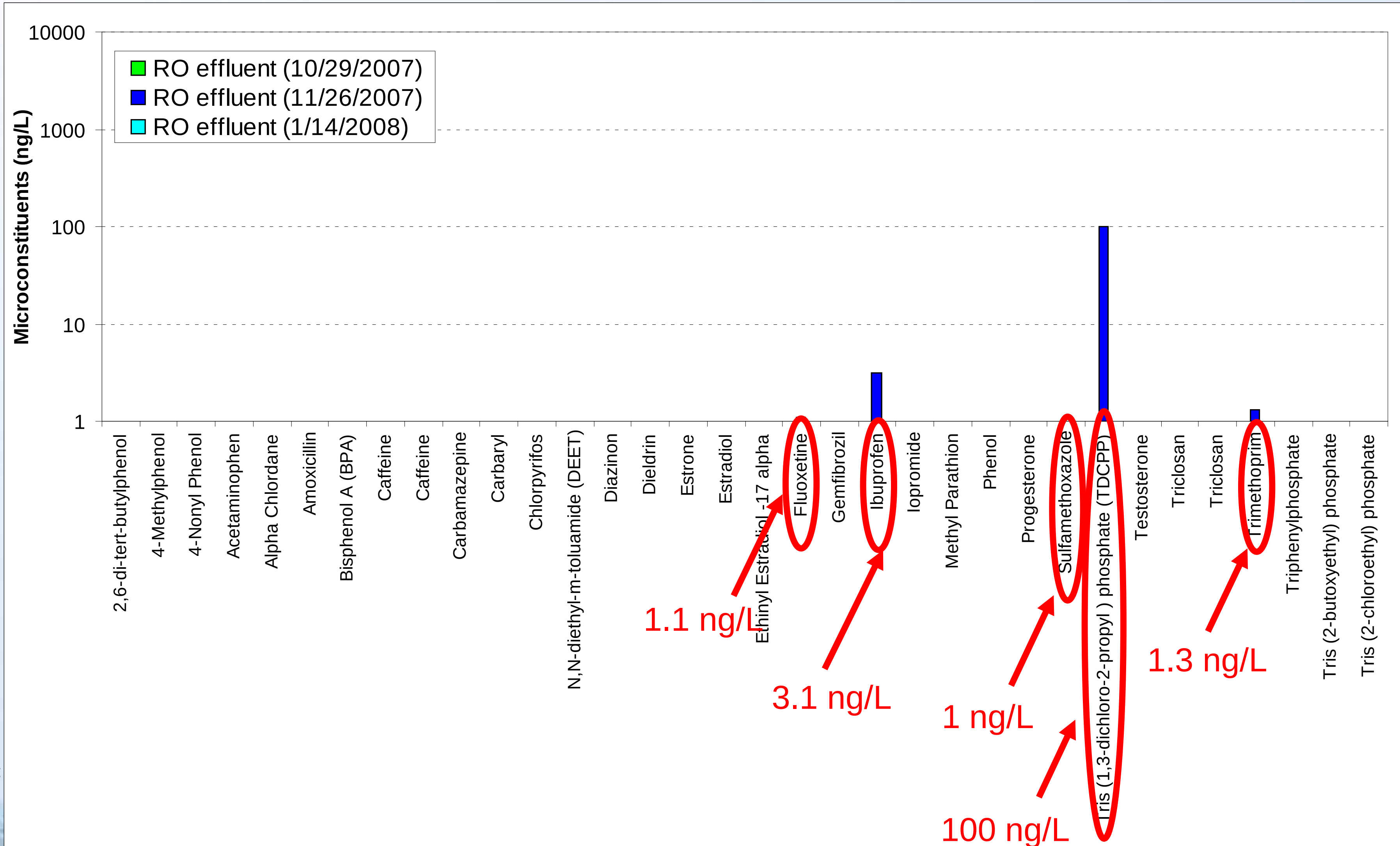
WRRF 06019 details membrane treatment and biological effluent impacts of TOrCs in reclaimed water


WATEREUSE RESEARCH

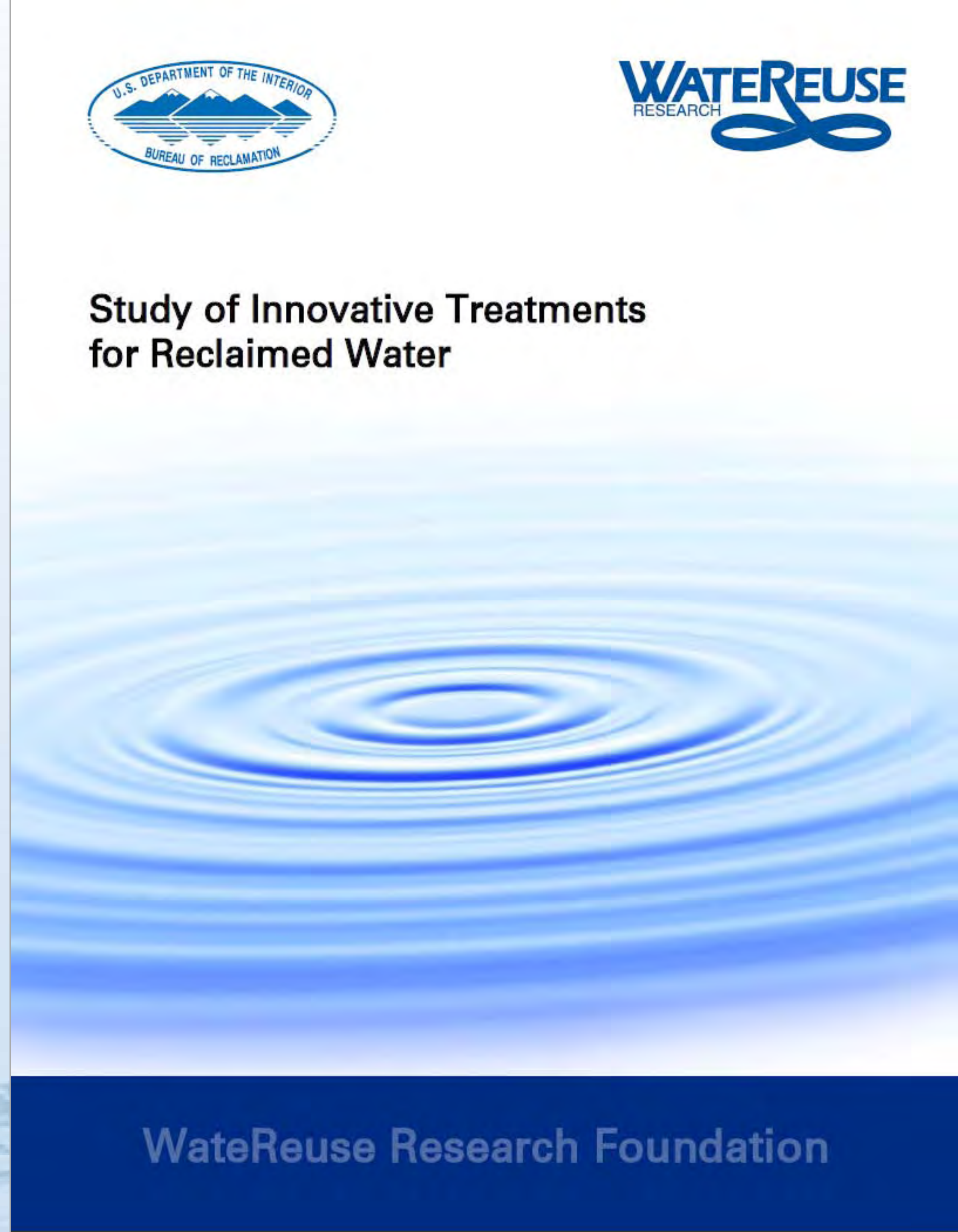
Monitoring for Microconstituents in an Advanced Wastewater Treatment Facility and Modeling Discharge of Reclaimed Water to Surface Canals for Indirect Potable Use

WateReuse Research Foundation

Nearly all TOrCs were removed by RO membranes

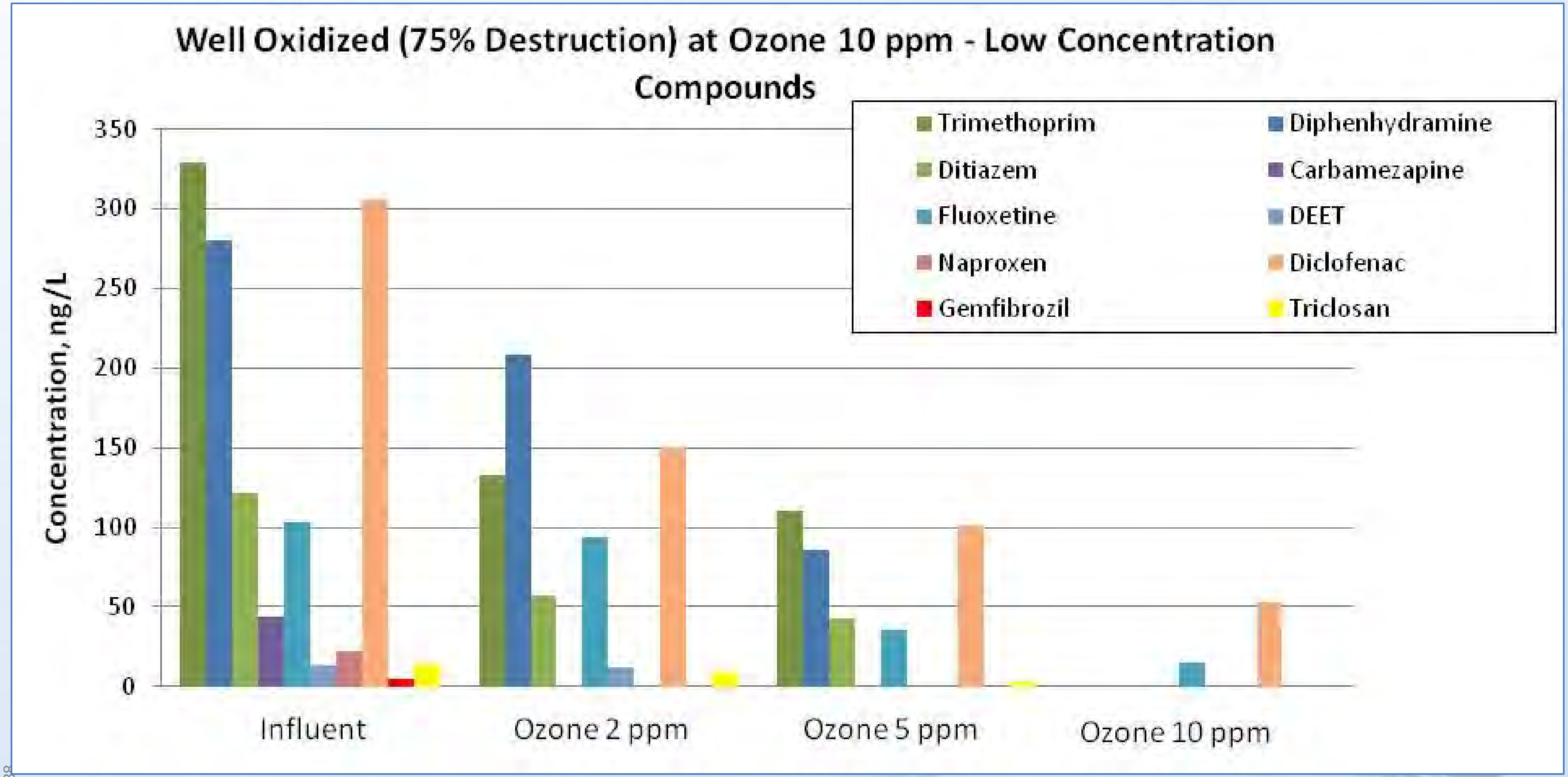


WRRF 02009 details advanced oxidation treatment of TOrCs and pathogens in reclaimed water

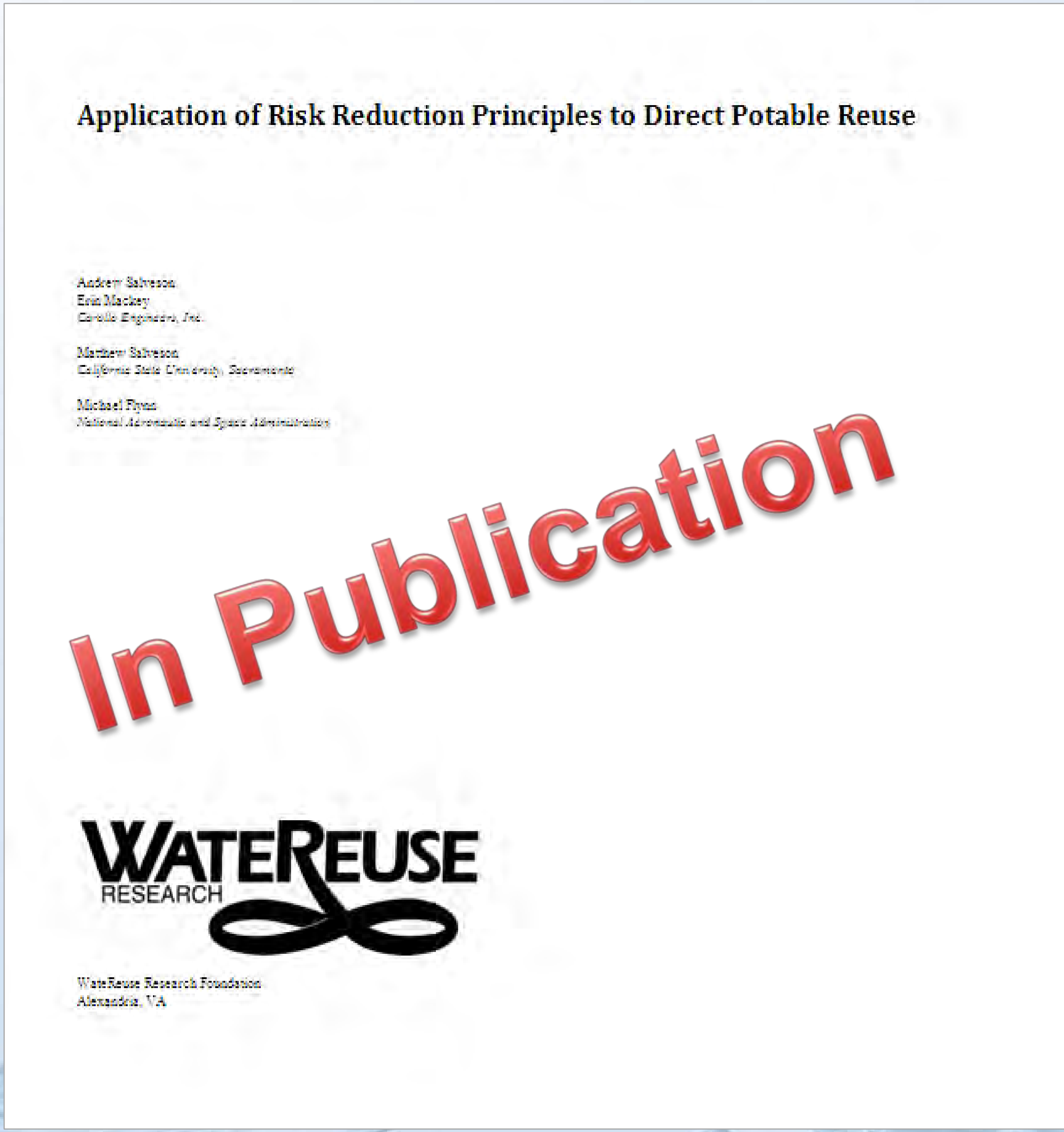


Wide range of technologies under analysis

Large database being developed for trace organics removal efficiency



WRRF 11-10 is the first step into how to safely implement DPR



Application of Risk Reduction Principles to Direct Potable Reuse

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National Aeronautics and Space Administration

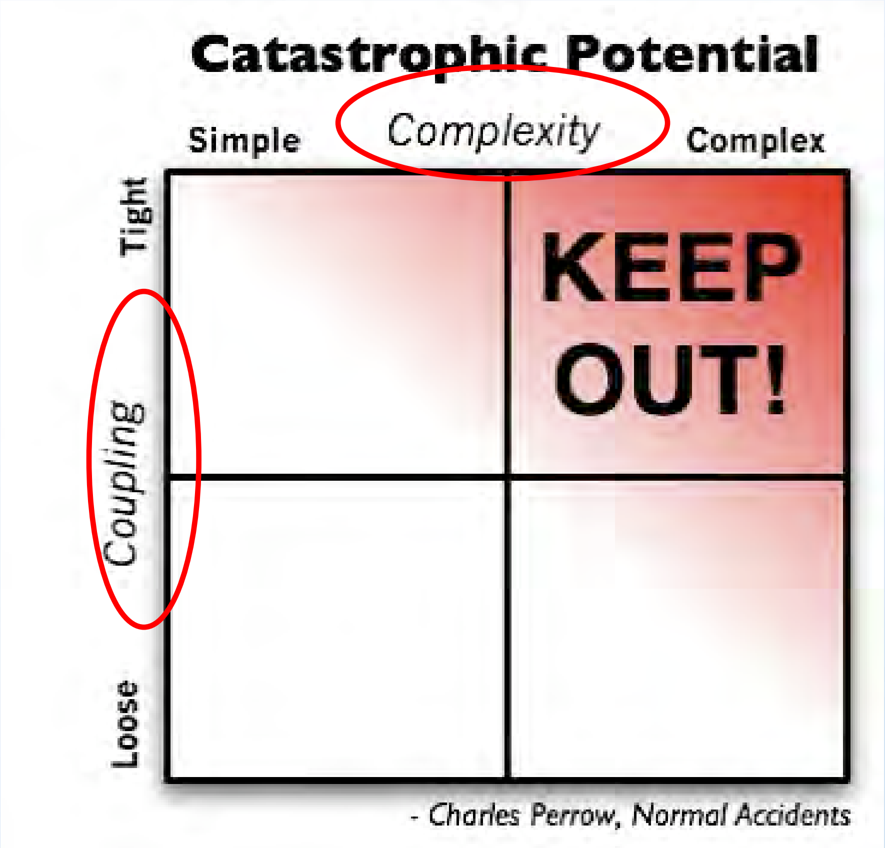
WateReuse Research Foundation
Alexandria, VA

Project Goal – *"A critical initial evaluation of DPR, including treatment, monitoring, and operation."*

- Identify important weak points in the advanced treatment process train.
- Look at how and when we can manage these risks.

Lessons learned

- Look for opportunities to make things simpler and/or less tightly coupled.
- Control potential failure points relative to their risk.
- Monitoring is key.
- For personnel:
  - Training, training, training.
  - SOPs for critical failure events.



WRRF 11-02, finding lower cost treatment for potable reuse

- WateReuse Research Foundation Project 11-02 *“Equivalency of Advanced Treatment Trains for Direct Potable Reuse”*

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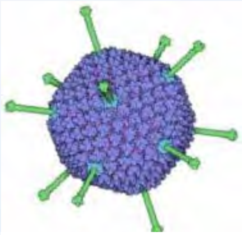
WATEREUSE RESEARCH

National Water Research Institute

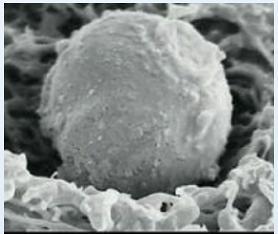
Overall Goal: How do we make DPR safe?

WRRF Project 11-02 Addresses Two Key Questions:

1. What level of treatment must we achieve?



Adenovirus

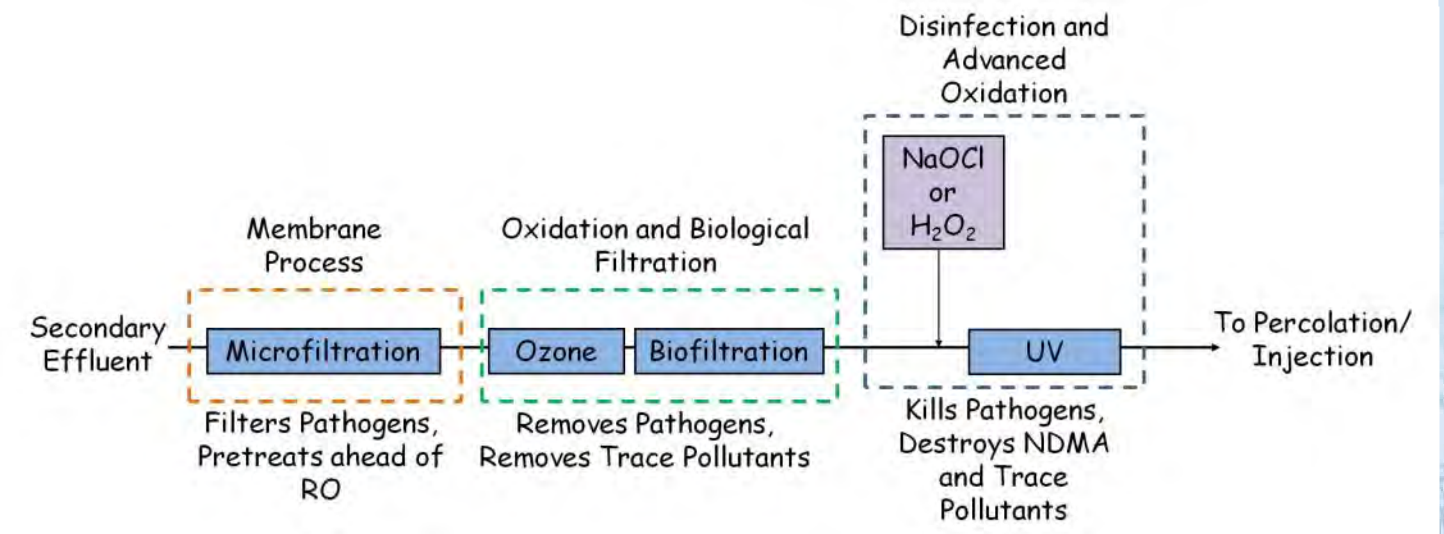


Cryptosporidium

fluoxetine

NDMA

2. How can we achieve that level of treatment?



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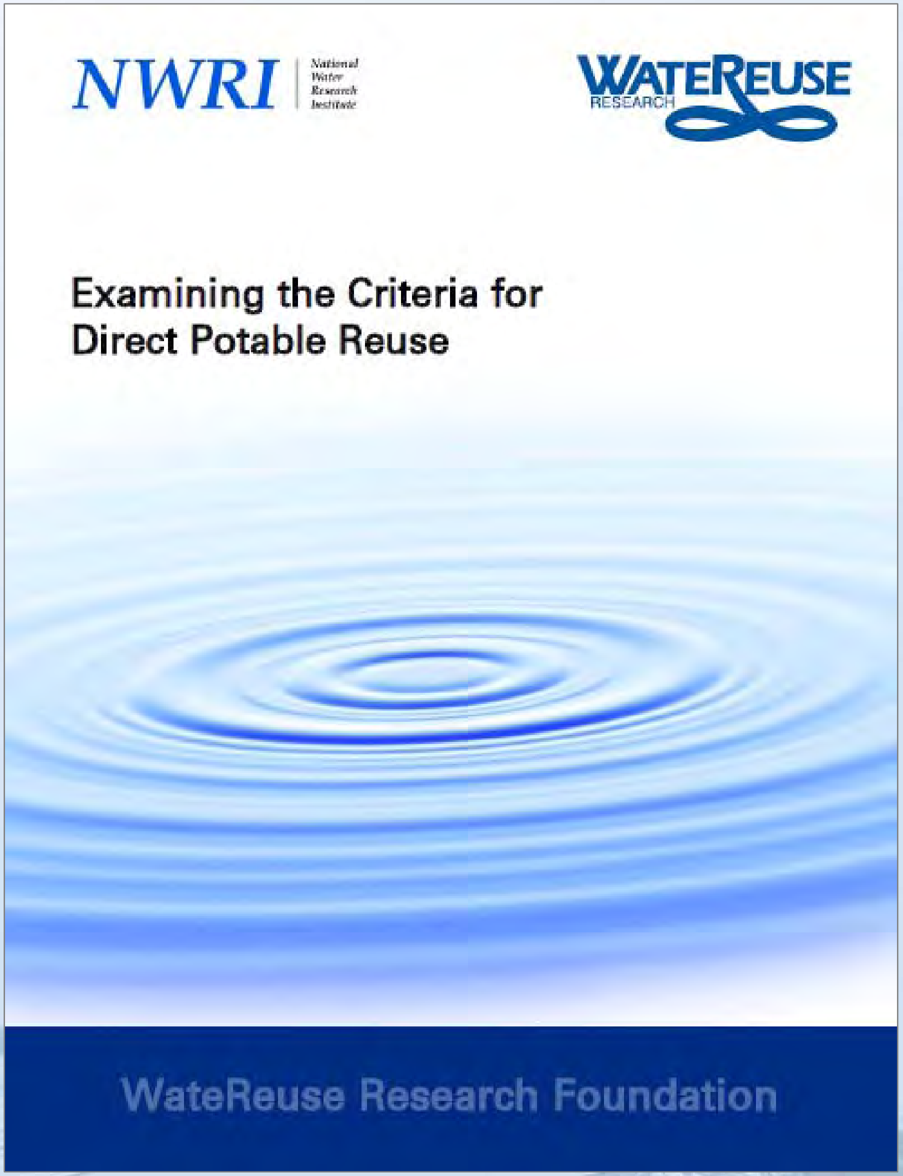
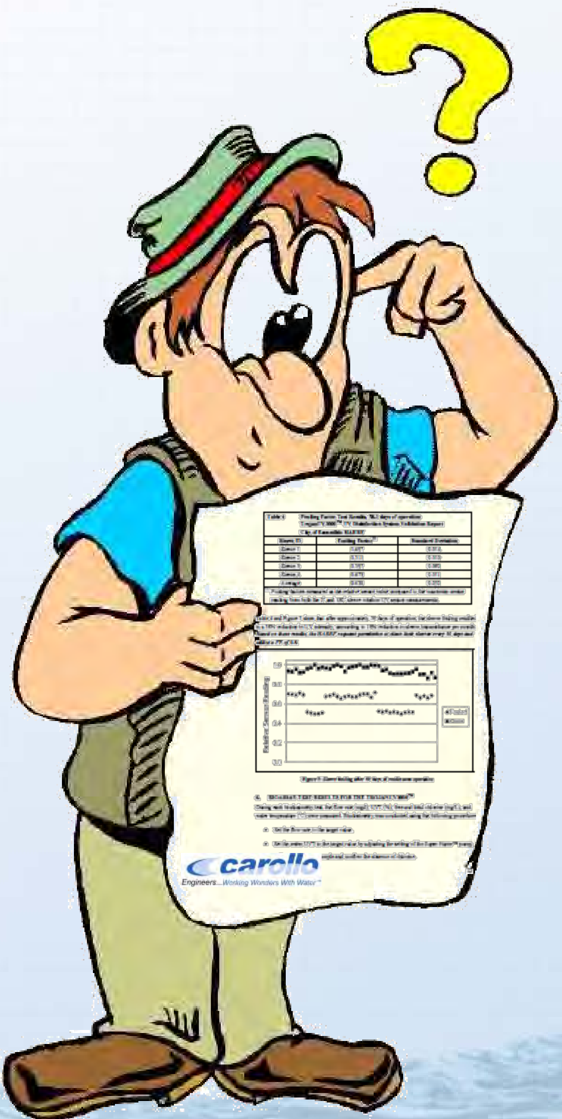
WRRF 11-02 Panel Report specifies treatment goals

- From Raw Wastewater to Potable Water
  - 12-log virus
  - 9-log bacteria
  - 10-log protozoa



Now we have all this information, but what do we do with it?

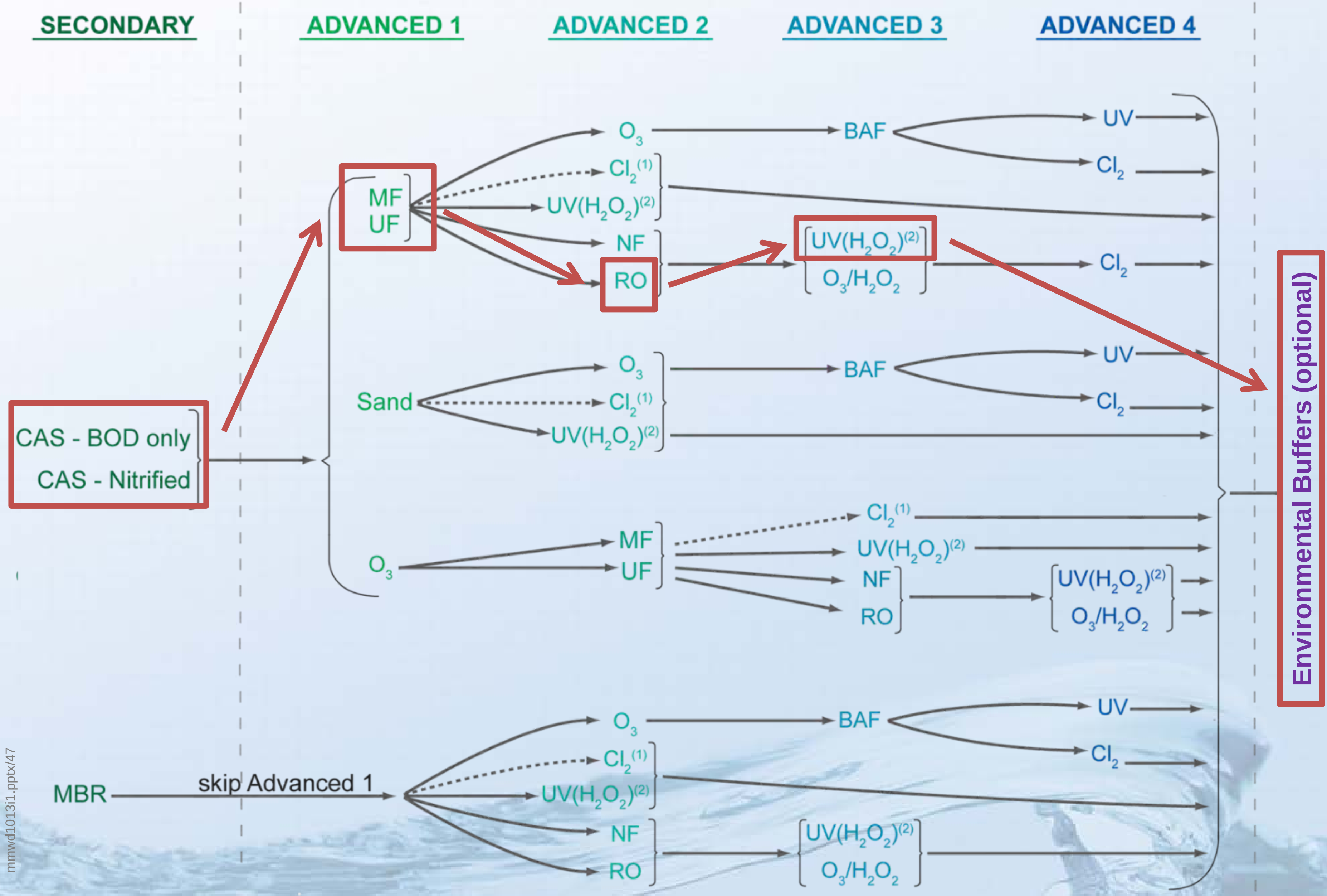
And… *can we achieve the desired removals <u>without reverse osmosis</u>?*



Step 1: Define "Performance Parameters"

Parameter	Removal Goal
Microbial	
Virus (*MS-2 bacteriophage*)	> 12-log
Protozoa (*Cryptosporidium*)	> 10-log
Bacteria (Total Coliform)	> 9-log
Chemical	
Trace Organic Compounds	< 1 ug/L
Estradiol Equivalency (EEQ)	< 5 ng/L
N-nitrosodimethylamine NDMA)	< 10 ng/L

Define Preferred Combinations



Work Through the Excel Interface for Results

WATEREUSE RESEARCH

Integrated Treatment Train Toolbox Potable Reuse IT³PR

DRAFT

SELECT YOUR TREATMENT TRAIN:

CA-style FAT for IPR

Secondary Treatment: Conventional Activated Sludge - Nutrient Removal

SRT: 7 days

Advanced 1: MF

Advanced 2: RO

Advanced 3: UV/H2O2

UV Dose: 250 mJ/cm2

Advanced 4: None

Optional Environmental Buffers: Direct Injection (Subsurface Migration Only)

Travel Time: 6 months

Selected Treatment Train:

	Treatment Goal	Influent Water	Effluent Water	Total Achieved Removal	Performance	
Bacteria	9-log			20.5-log		meets criteria
Virus	12-log			18.5-log		meets criteria
Protozoa (Crypto)	10-log			18.0-log		meets criteria
EEQ	50%	10 ng/L	0.1 ng/L	99.0%		meets criteria
TOrCs	80%	5 ug/L	.08 ug/L	98.5%		meets criteria
NDMA	90%	100 ng/L	10.0 ng/L	90.0%		minimally meets criteria

Latest WaterRF DPR Research Assesses a Range of Blending Approaches

- Secondary Effluent with Raw Water
- Purified Water with Raw Water
- Purified Water with Finished Water
- …and interactions in between.

Path Forward for Potable Reuse

Progress will be a function of…

- Scarcity / Options
- Provider Interest
- Technology & Costs
- Public Acceptance

Groundwater Augmentation

Direct Potable Reuse

Regs for Surface Water Augmentation

Monitor Research and Other States' Approaches

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