Federal Guidance on Development of Potable Reuse

Greg Wetterau

Supplement to EPA *Guidelines For Water Reuse*

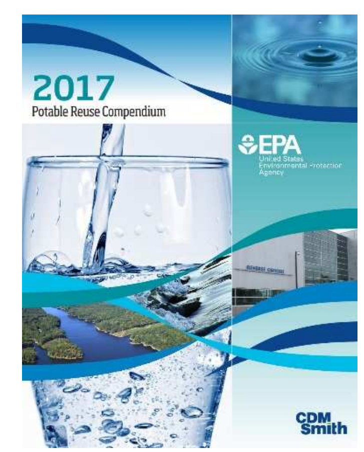
1980

1992

2004

2012

2017 Potable Reuse Compendium discusses of state of the practice

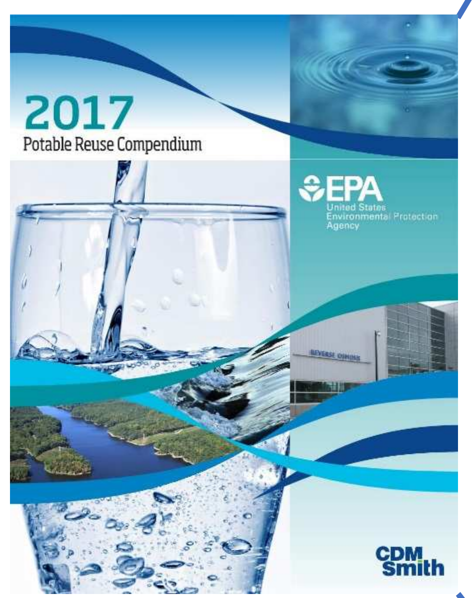


Scope of 2017 Compendium

Technical Resource

Regulatory Document

Scope of the Document	
Not included	**Included – state of the industry**
National regulation for potable reuse	Summary of federal laws impacting potable reuse and state regulatory frameworks for potable reuse
Promotion of potable reuse	Opportunities, challenges and trends in potable reuse
Design or treatment requirements for potable reuse	Potable reuse applications, treatment technologies, research results, and case studies.

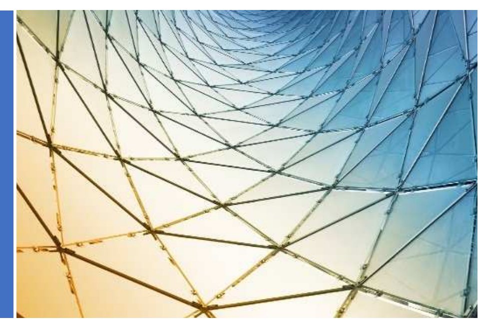


Organization of the document	
Chapter 1	Introduction
Chapter 2	Potable Reuse in the United States and Abroad
Chapter 3	Safe Drinking Water Act and Clean Water Act: Opportunities for Water Reuse
Chapter 4	Constituents in Potable Reuse Water Sources
Chapter 5	Risk Analysis
Chapter 6	Treatment Technologies for Potable Reuse
Chapter 7	Alternative Treatment Trains for Potable Reuse
Chapter 8	Source Control
Chapter 9	Environmental and Engineered Buffers
Chapter 10	Training, Operating, and Monitoring
Chapter 11	Cost of Potable Reuse
Chapter 12	Epidemiological and Related Studies
Chapter 13	Public Acceptance
Chapter 14	Research
Chapter 15	References
Appendices	Case Studies

Intended Audience of the Document	
Who	**Benefit**
Regulatory agencies	Resource document for reference when developing or revising potable water reuse standards.
Planners and decision-makers	Resource document for reference during evaluation, planning, design, or operation of potable water reclamation facilities.
Reclaimed water users	Resource document for better understanding potable reuse.

Potable Reuse Reports & Guidance

		Year	US overview	Chemicals	Pathogens	Risk Assess.	Reg. Summ.	Treatment	Source Ctrl.	Buffers	Monitoring	Operations	Cost	Epidemio.	Public	Research	Case studies
1	WEF/AWWA – Using Reclaimed Water	2008		✓	✓		✓	✓				✓			✓		✓
2	NWRI - A Path Forward (WRRF 11-00)	2011						✓	✓	✓	✓				✓	✓	✓
3	National Research Council	2012	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
4	State of the Science Report and Equivalency Criteria for Treatment Trains (WRRF 11-02-2)	2013		✓	✓		✓	✓		✓	✓					✓	✓
5	Australian Academy of Technological Sciences and Engineering – Australia-specific	2013	✓	✓	✓		✓	✓		✓			✓		✓		✓
6	Direct Potable Reuse Resource Document (TWDB) – Texas-specific	2015		✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	
7	Framework for Direct Potable Reuse (AWWA, NWRI, WEF, and WateReuse)	2015				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
8	WHO – Potable Reuse: Guidance for Producing Safe Drinking Water	2017	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓
9	EPA Potable Reuse Supplement	2017	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

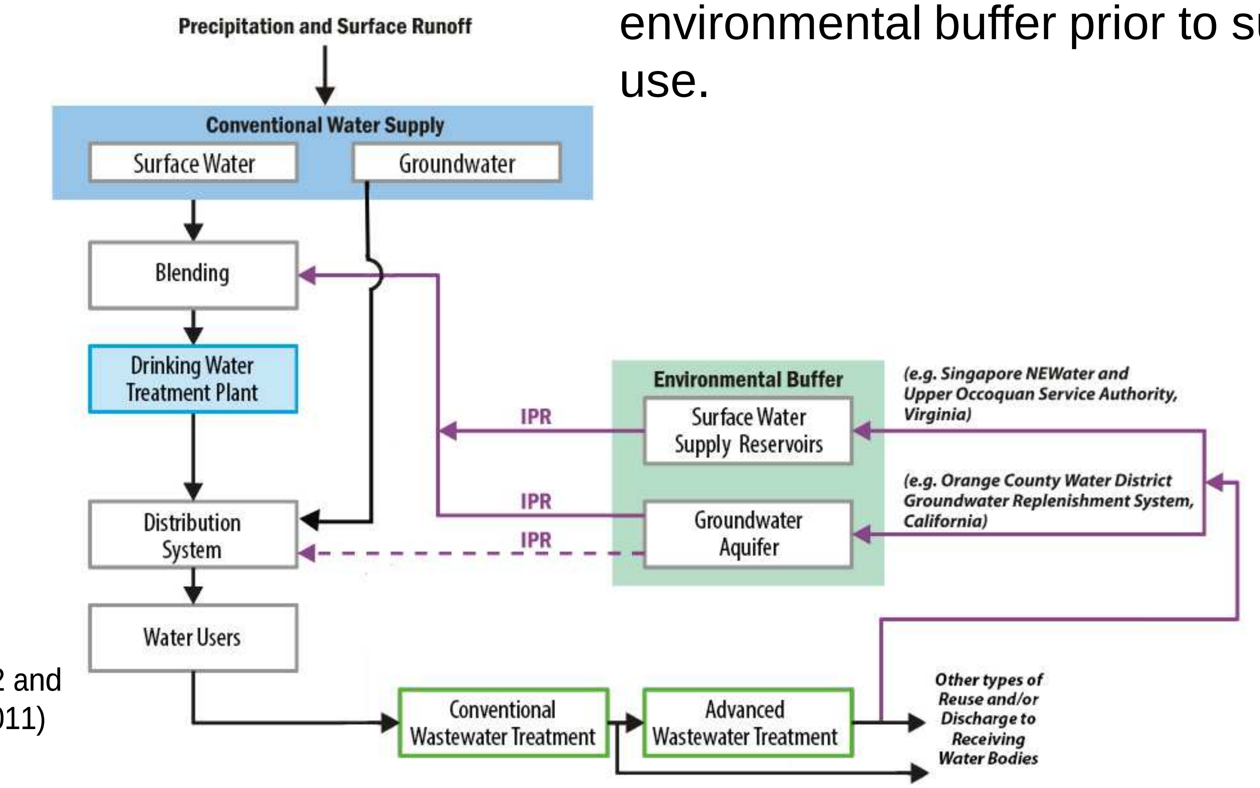


Document Content

Terminology

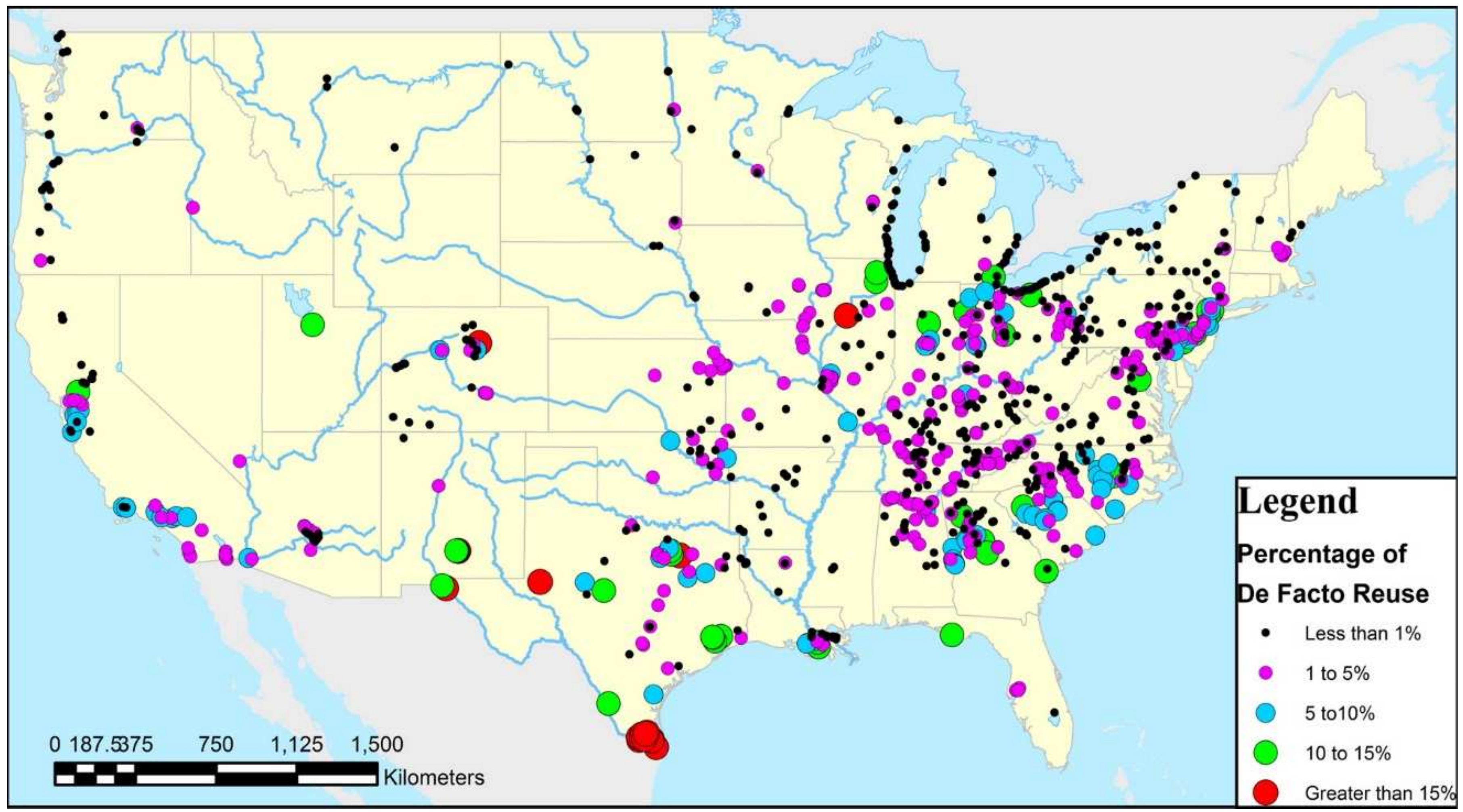
***De facto* reuse:** A situation where reuse of treated wastewater is practiced but is not officially recognized (e.g., a drinking water supply intake located downstream from a WWTP discharge point).

Indirect potable reuse (IPR): Deliberative augmentation of a drinking water source (surface water or groundwater aquifer) with treated reclaimed water, which provides an environmental buffer prior to subsequent use.



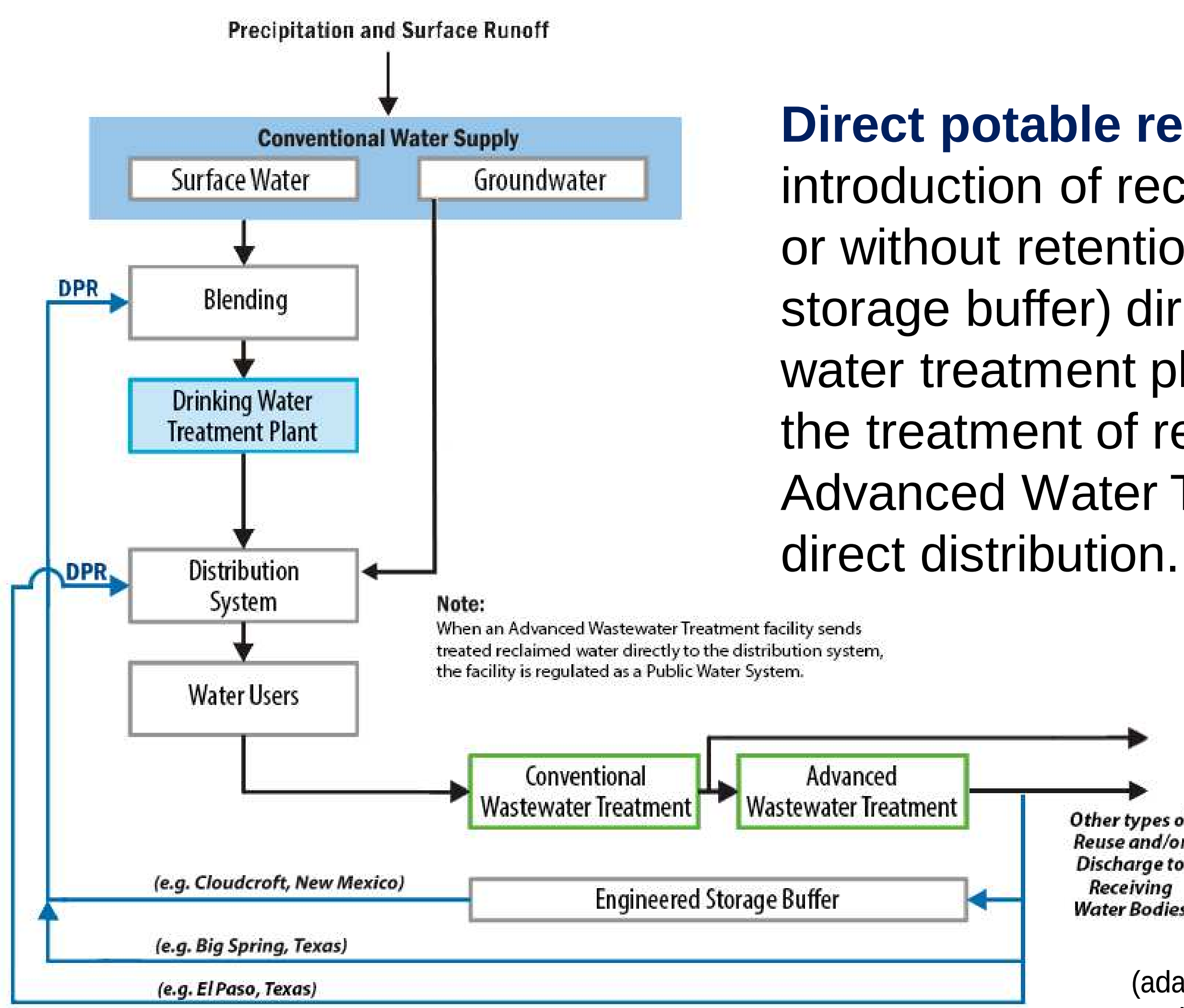
(adapted from EPA 2012 and Tchobanoglous et al., 2011)

De facto Reuse in U.S.



Source: Rice and Westerhoff (2015) Environ. Sci. Technol. 49 (2) 982-989

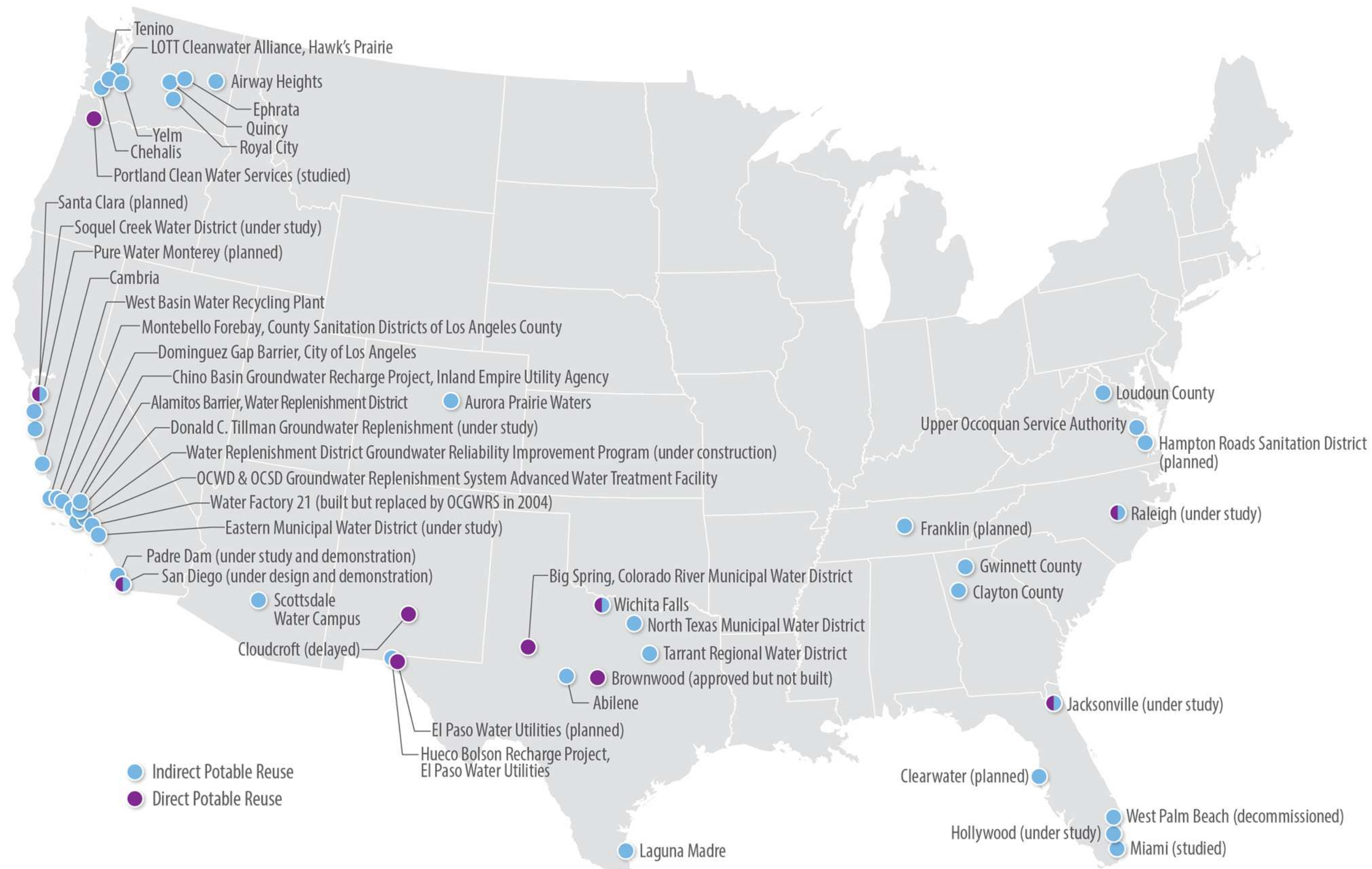
Terminology



Direct potable reuse (DPR): The introduction of reclaimed water (with or without retention in an engineered storage buffer) directly into a drinking water treatment plant. This includes the treatment of reclaimed water at an Advanced Water Treatment Plant for direct distribution.

(adapted from EPA 2012 and Tchobanoglous et al., 2011)

Planned Potable Reuse in U.S.

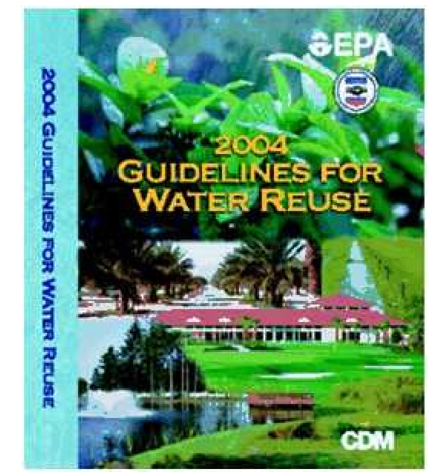


Planned Potable Reuse Outside the U.S.

EPA *Guidelines for Water Reuse*

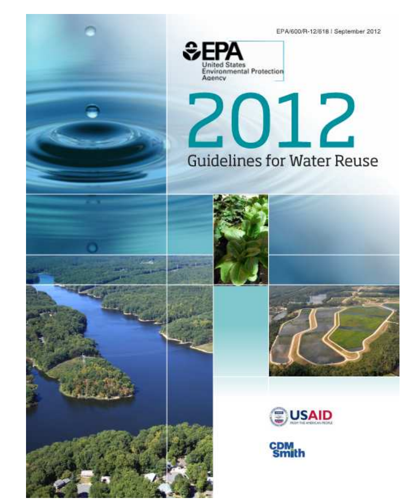
- “DPR will seldom be necessary.”
- “While DPR may not be considered a viable option at this time, many states are moving forward with IPR projects.”

2004



- “In many parts of the world, DPR may be the most economical and reliable method of meeting future water supply needs. While DPR is still an emerging practice, it should be evaluated in water management planning, particularly for alternative solutions to meet urban water supply requirements that are energy intensive and ecologically unfavorable. This is consistent with the established engineering practice of selecting the highest quality source water available for drinking water production.”

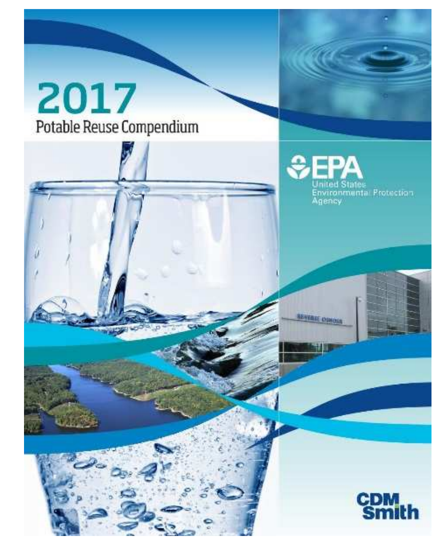
2012



EPA Potable Reuse Compendium

- "EPA supports water reuse as part of an integrated water resources management approach developed at the state and local level to meet the water needs of multiple sectors including agriculture, industry, drinking water, and ecosystem protection."
- "The SDWA and the CWA provide a foundation from which states can further develop and support potable water reuse as they deem appropriate."

2017



Regulating Reuse

- SDWA and CWA authorize EPA to set national standards, EPA provides guidance (*Guidelines for Water Reuse*)
- Delegates implementation and enforcement responsibility to states, territories, and Tribes (42 U.S.C. §300g--2)
- Examples: California Water Board Division of Drinking Water (DDW), Texas Commission on Environmental Quality (TCEQ), Oklahoma Department on Environmental Quality (ODEQ), Georgia Environmental Protection Division (EPD)

Water Boards

Texas Commission on Environmental Quality

DEQ Oklahoma Department of Environmental Quality

Georgia Environmental Protection Division

Regulatory Status of Potable Reuse

Category of Reuse	Number of States with Policies to Address Potable Reuse in 2012	Number of States with Policies to Address Potable Reuse in 2017
IPR	8 (AZ, CA, FL, HI, MA, PA, VA, WA)	14 (AZ, CA ,FL ,HI ,**ID** ,MA ,**NV**, **NC**, **OK**, **OR**, PA, **TX**, VA, WA)
DPR	0	3 (CA, NC, TX)

Regulatory Status of Potable Reuse

- Massachusetts
  - Adopted non-potable reuse regulations in 2009
  - Requires 6 month minimum travel time between outside use of reclaimed water and nearest drinking water withdrawal
- New York
  - No regulations identified as potable or non-potable reuse
  - Require 60-day travel time between wastewater discharge and nearest drinking water intake
  - Giardia and virus treatment required if discharging to watercourse impacting potable supply
- No reuse regulations in Connecticut, requiring case-by-case approval for specific projects

Constituents in Water Sources Chapter 4

- Chemical with Potential Health Risks
  - Many regulated with MCLs
  - TrOC, unregulated DBPs
  - Generally related to chronic health risks
  - Can cause acute risks if concentrations high enough
- Pathogens
  - Present acute health risks
  - Regulated by both SDWA and CWA

Chemical Substances in Wastewater

Origin	Sources of Chemical Substance	Examples of Specific Chemical Substances
Industrial	Pesticides, preservatives, flame retardants, perfluorochemicals, nanoparticles	Plasticizers, heat stabilizers, biocides, epoxy resins, bleaching chemicals, solvents, dyes, polymers, hydrocarbons, phthalates, atrazine, DEET
Domestic	Personal care products, surfactants	Laundry detergent, ammonia, bleach, antifreeze, lotions, perfume
Human-based	Steroidal hormones, pharmaceutical residues	Oestradiol, oestrone, testosterone, trimethoprim, caffeine, ibuprofen, gemfibrozil, sulfamethoxazole, carbamazepine
Formed during WW treatment	Disinfection by-products	THMs, HAAs, NDMA, NDEA, aldehydes, bromate, chlorate

- TrOC concentrations range from ng/L to hundreds of µg/L, compared with TOC in mg/L range

Removing TrOC with Advanced Treatment

Chemical	Orange County GWR System (June 2010)				
	Influent	ROF	ROP	UVP	FPW
Acetaminophen	78	238	15	ND	ND
Caffeine	1060	1190	5.2	ND	ND
Carbamazepine	263	250	ND	ND	ND
DEET	528	552	4	ND	ND
Dilantin	197	152	ND	ND	ND
Diuron	66	73	ND	ND	ND
Ethinyl Estradiaol	ND	ND	ND	ND	ND
Gemfibrozil	802	778	ND	ND	ND
Ibuprofen	280	352	ND	ND	ND
Meprobramate	408	ND	ND	ND	ND
NDMA	30	27	12	ND	ND
Primidone	100	100	ND	ND	ND
Sulfamethoxazole	1020	1.2	ND	ND	ND
TCEP	338	353	ND	ND	ND
Triclosan	324	101	6.2	ND	ND

Disinfection Byproducts

- Many DBPs poorly removed by RO
- Will become increasing focus as IPR/DPR expand

DBP	MCL	Surface Water	Potable Reuse
THMs	80 µg/L	Forms with NOM and free Cl2 Controlled with chloramines or TOC reduction	Poorly removed by RO and AOP Typically low, given use of chloramines Formation low after RO
HAAs	60 µg/L	Forms with NOM and free Cl2 Controlled with chloramines or TOC reduction	Well removed by RO Typically low, given use of chloramines
Bromate	10 µg/L	Forms with bromide and ozone Controlled with pH, source control	Potential concern if ozone used for AOP
Chlorite	1 mg/L	Forms with chlorine dioxide	Potential formation from UV/Chlorine
NDMA	NL = 10 ng/L	Generally low in natural waters Being considered for future regulation	Forms with EfOM and chloramines Requires UV to reduce Formation may be controlled

Pathogens in Wastewater

Pathogenic Organism	Examples	Max Density in Wastewater (per L)	Median Infective Dose (ID50) Category
Bacteria	Campylobacter Salmonella	10^5 10^8	~10^6
Viruses	Adenoviruses Noroviruses	10^4 10^9	$<10^2$
Protozoa	Giardia Cryptosporidium	10^5 10^5	$<10^2$

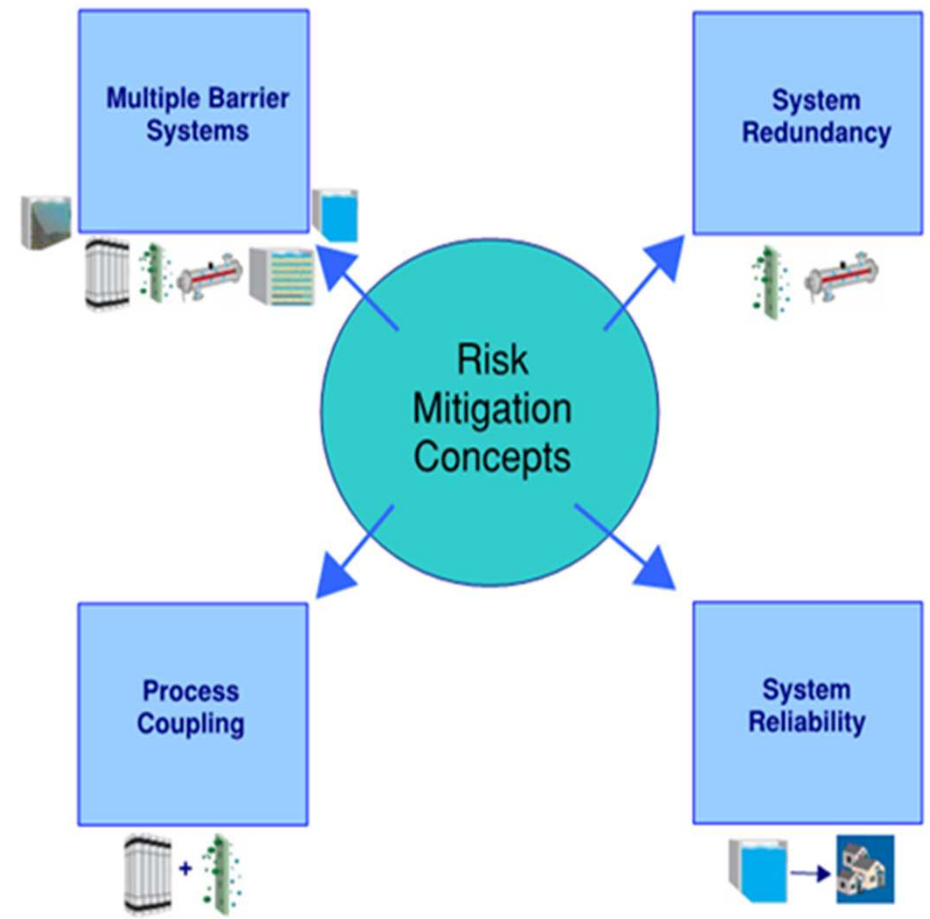
Adapted from Soller et al, 2018, Feachem et al., 1983; Messner et al., 2014, 2016; Teunis et al., 2008

Pathogen Removal Requirements

	Virus	Bacteria	Protozoa	Included Processes
California	12	No Rq’t	10 – Giardia 10 – Crypto	Raw WW to DW distribution
Texas	8 to 9	No Rq’t	6 to 8 – Giardia 5.5 – Crypto	WW effluent to DW distribution
Western Australia	9.5	8.1 – Campylobacter	8 - Crypto	Advanced treatment only

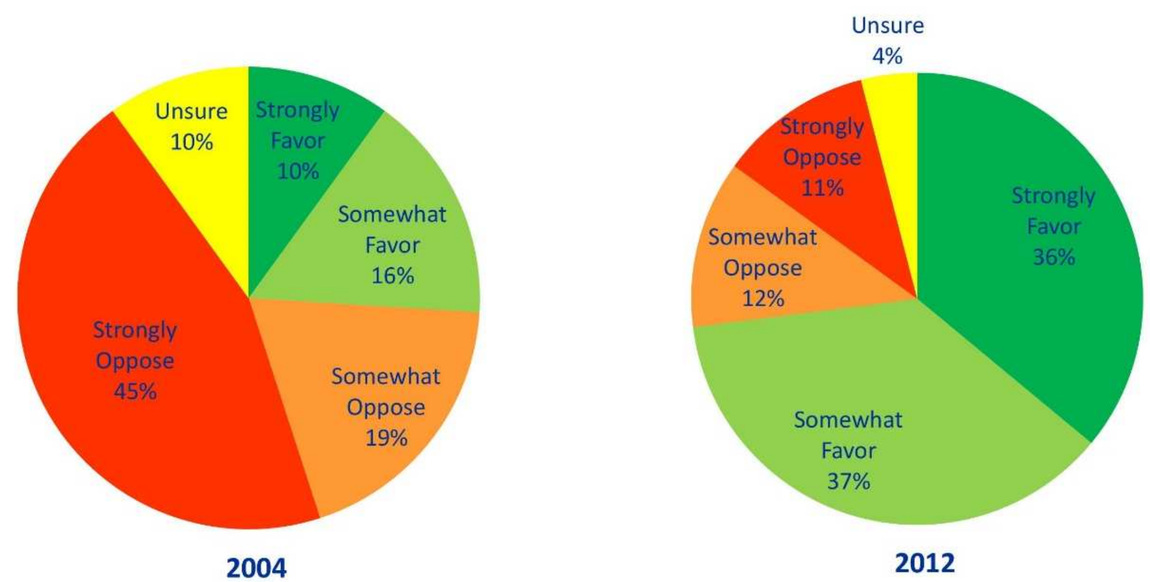
Risk Analysis

- Quantitative Risk Assessment
  - Chemicals – 1 in 1,000,000
  - Pathogens (QMRA) – 1 in 10,000
- Alternative Risk Models
  - Relative Risk Assessment
  - Probabilistic Risk Assessment
- Risk Management



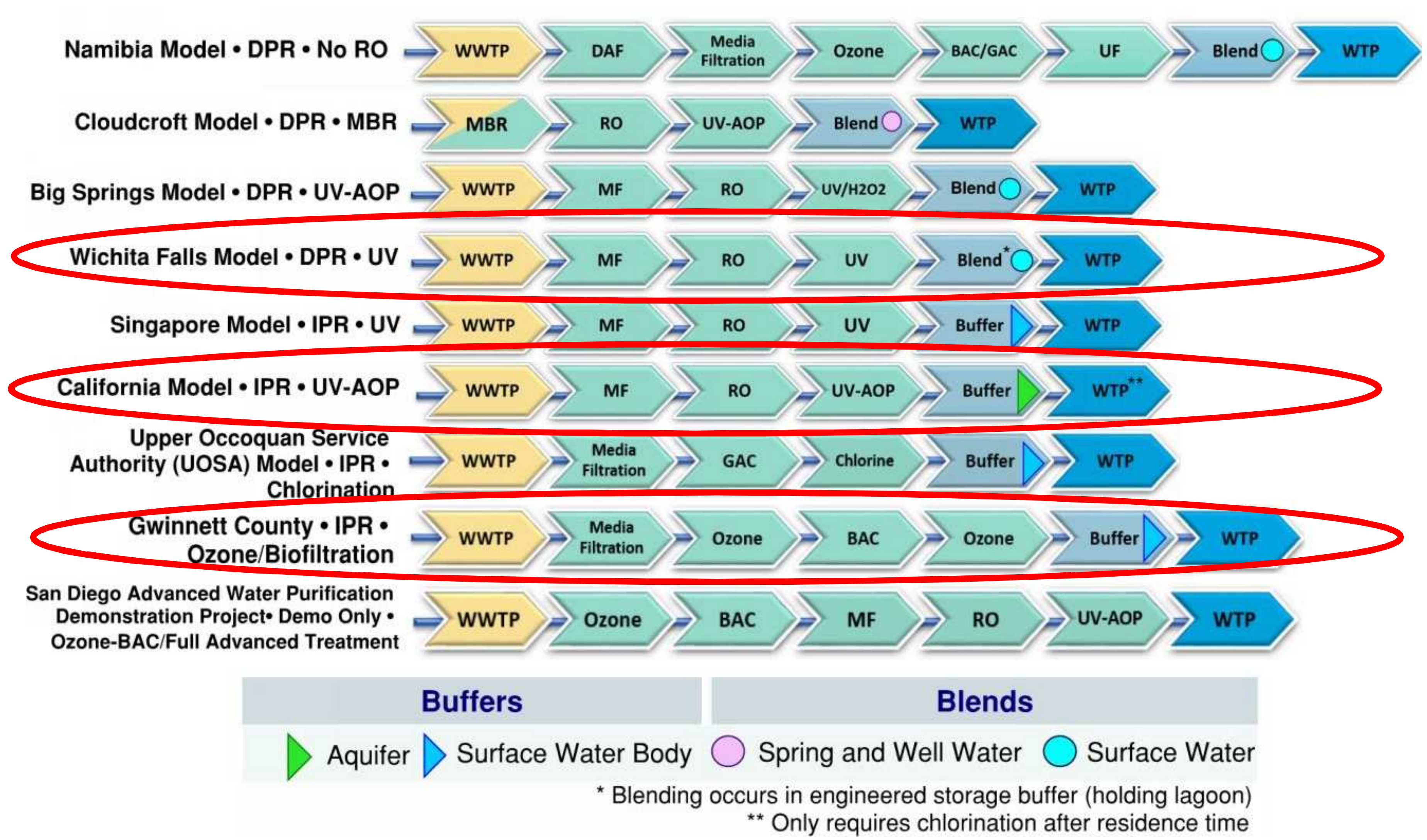
Public critical to success of potable reuse projects

Do you support using advanced treated recycled water as an addition to drinking water supply?



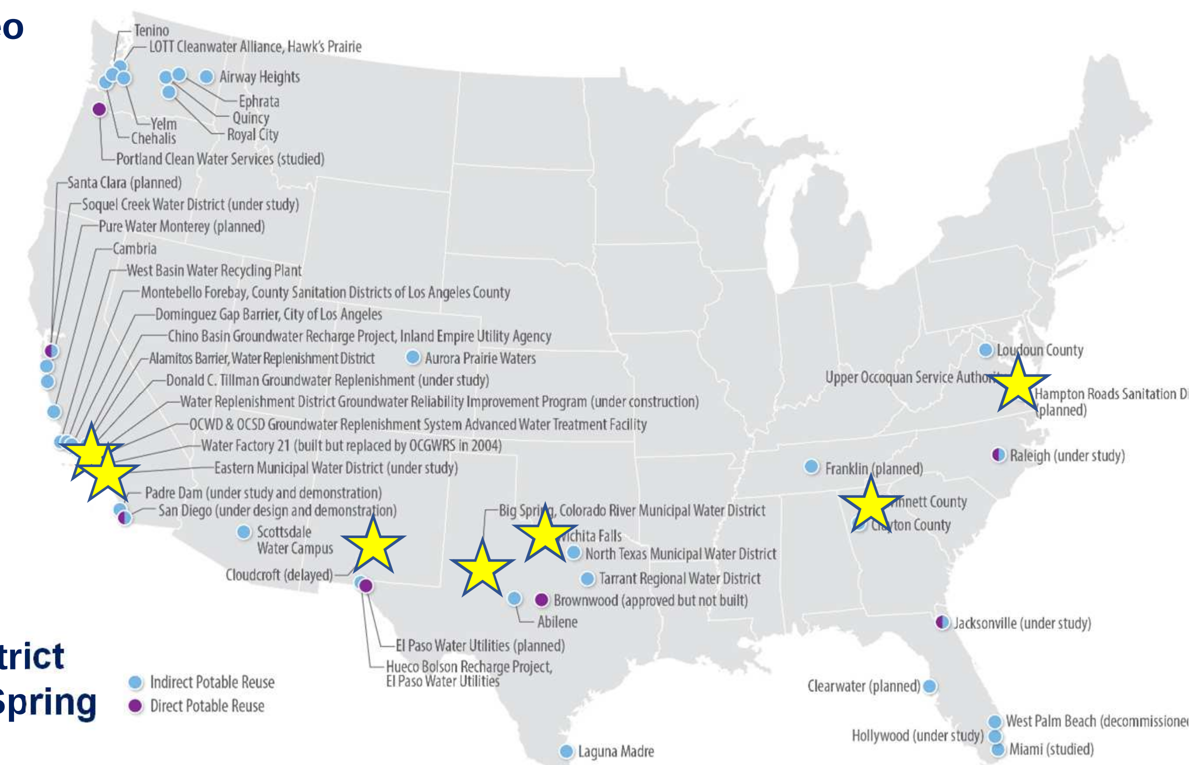
Courtesy of San Diego County Water Authority

Alternative Treatment Trains



Case Studies

- Los Alamitos Barrier Water Replenishment District of So. CA/Leo J. Vander Lans Advanced Water Treatment Facility (LVLWTF)
- Gwinnett F. Wayne Hill Water Resources Center, Chattahoochee River and Lake Lanier Discharge
- Village of Cloudcroft PURe Water Project – Direct Potable Reuse
- Orange County Groundwater Replenishment System (GWRS) Advanced Water Treatment Facility
- Colorado River Municipal Water District Raw Water Production Facility Big Spring Plant
- Wichita Falls River Road WWTP and Cypress WTP Permanent IPR and Emergency DPR Project
- Potable Water Reuse in the Occoquan Watershed



Case Studies

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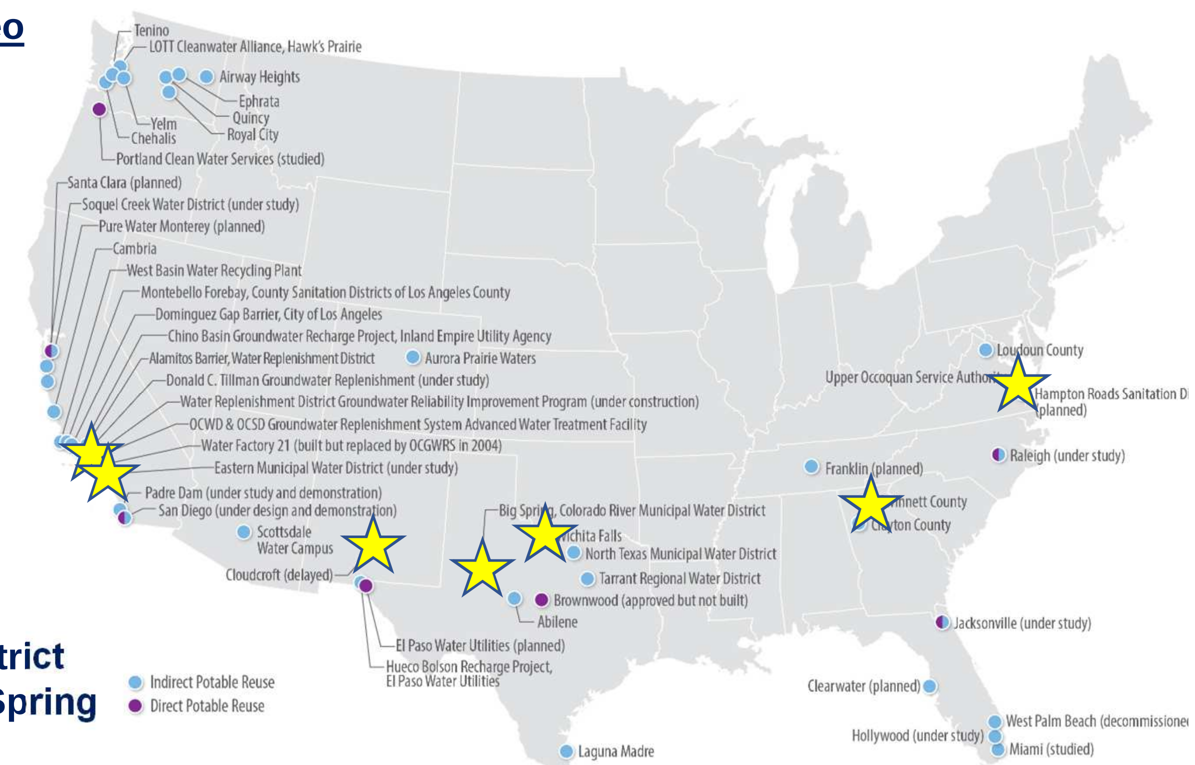
- **[Gwinnett F. Wayne Hill Water Resources Center, Chattahoochee River and Lake Lanier Discharge]**
- **Village of Cloudcroft PURe Water Project – Direct Potable Reuse**
- **Orange County Groundwater Replenishment System (GWRS) Advanced Water Treatment Facility**
- **Colorado River Municipal Water District Raw Water Production Facility Big Spring Plant**
- **[Wichita Falls River Road WWTP and Cypress WTP Permanent IPR and Emergency DPR Project]**
- **Potable Water Reuse in the Occoquan Watershed**



Water Replenishment District, CA

Water Replenishment District (WRD)

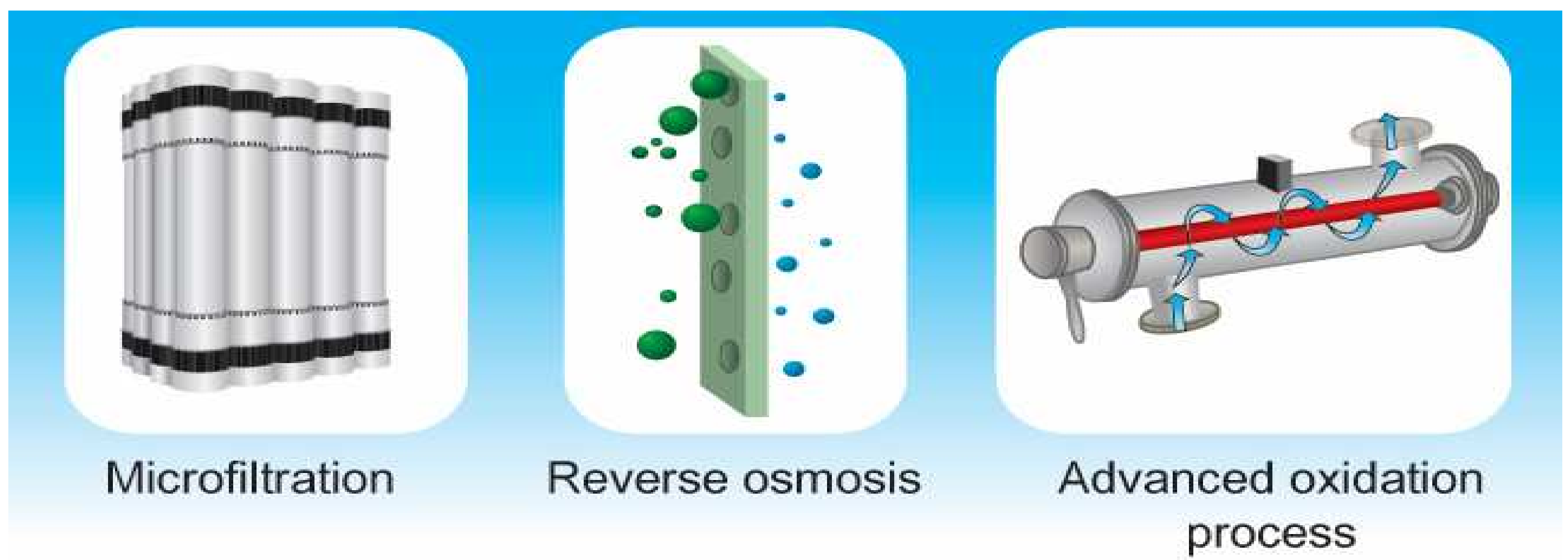
- Established: 1959 to manage groundwater in Los Angeles County
- Area: 1,090 km^2
- Population: 4 million
- Purpose: Manage Central and West Coast groundwater basins
- Facilities:
  - Goldsworthy Desalter
  - Vander Lans WTP
  - Alamitos, Dominguez Gap, and West Coast Barriers

Leo J. Vander Lans Water Treatment Facility

- Expanded from 3 to 8 mgd
- Process:
  - Tertiary filtered water
  - Microfiltration/RO/UV-AOP
- Status:
  - Initial facility Oct 2002
  - Expansion Oct 2014
- Improvements
  - Added recycle of MF backwash
  - Increase RO recovery to 93%
  - Added peroxide to UV to create AOP
  - Comply with new IPR regulations

Full Advanced Treatment

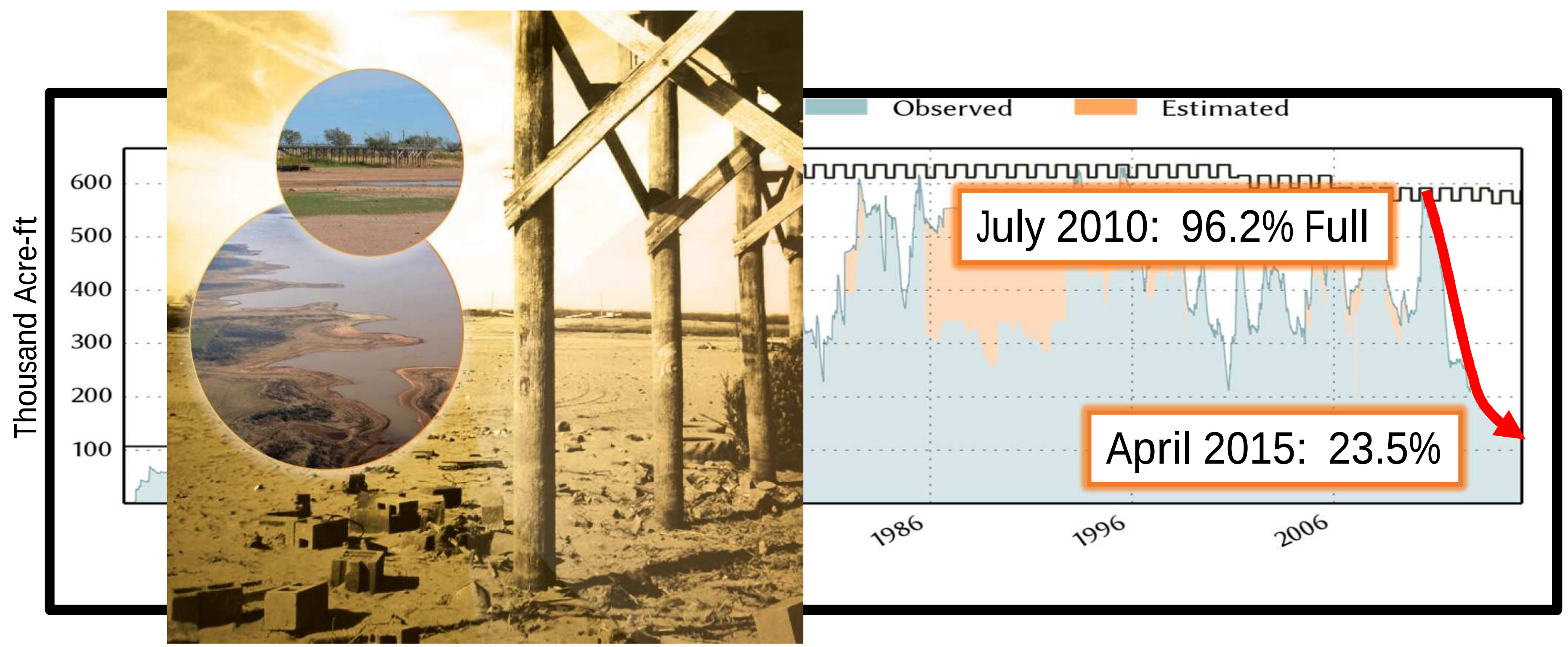
- Uses 3-step process similar to other California IPR projects
- First facility approved for 2 month travel time from injection to extraction
- 4 similar facilities currently operating in California



Wichita Falls, TX

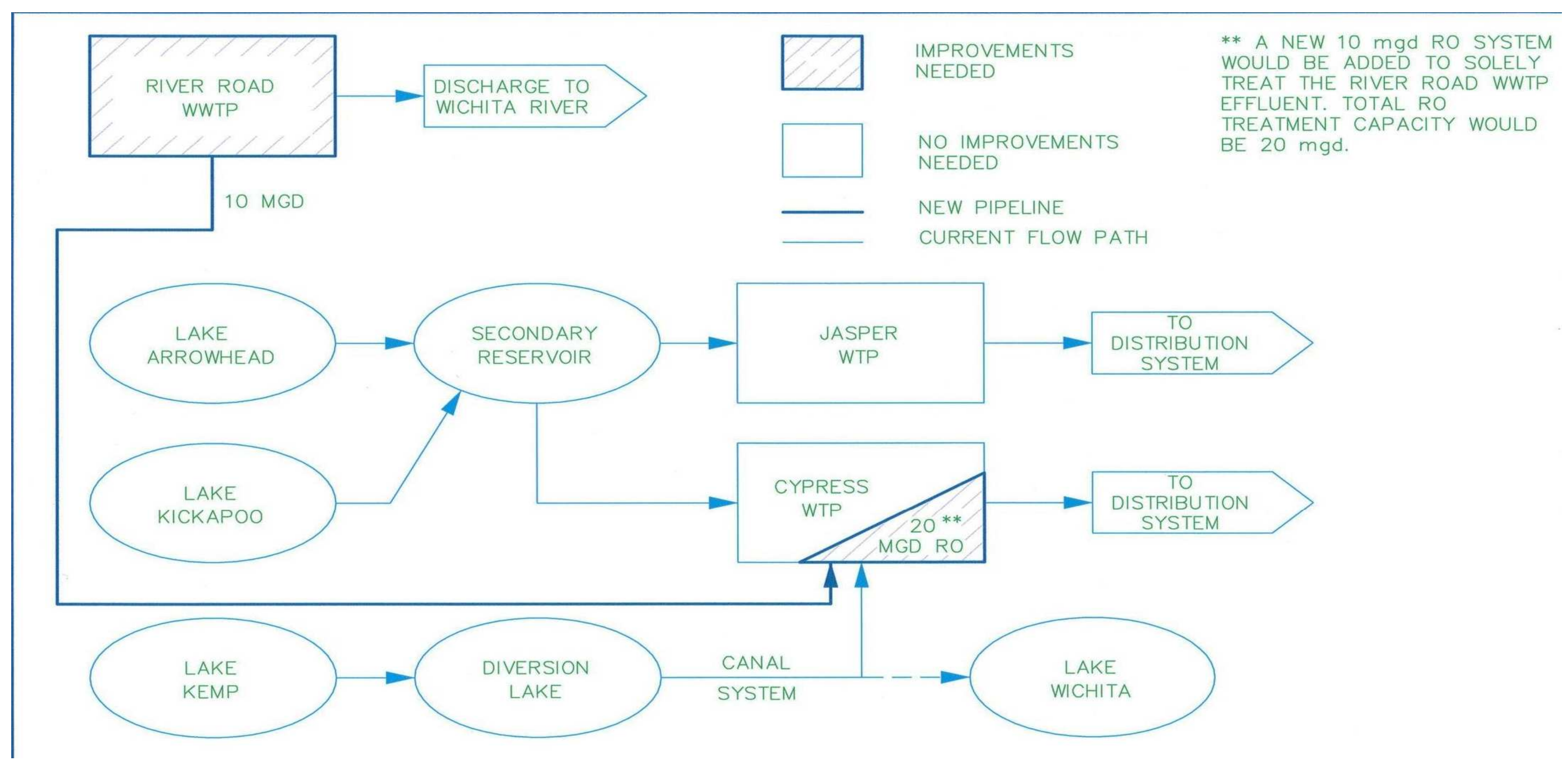
Wichita Falls Water Supply Lakes

How an unprecedented drought affected the city's three surface water supplies

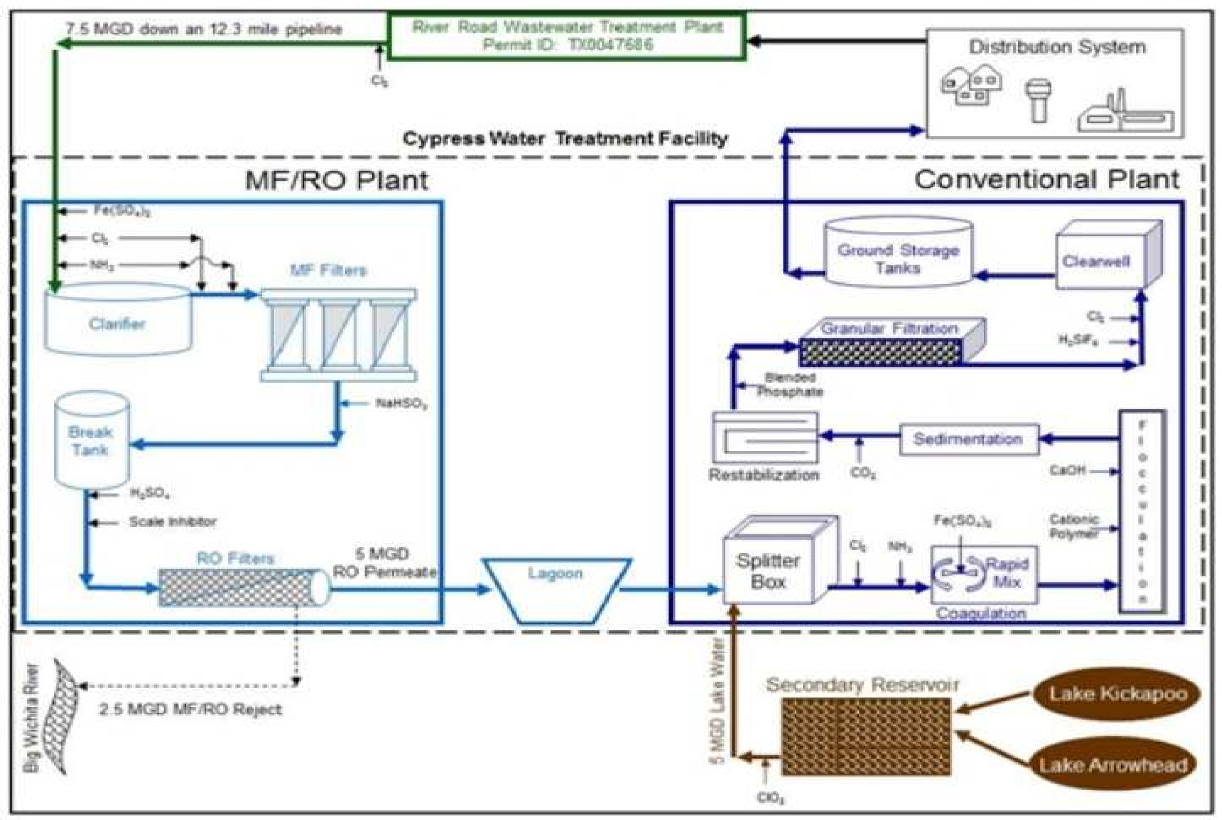


Source: http://waterdatafortexas.org

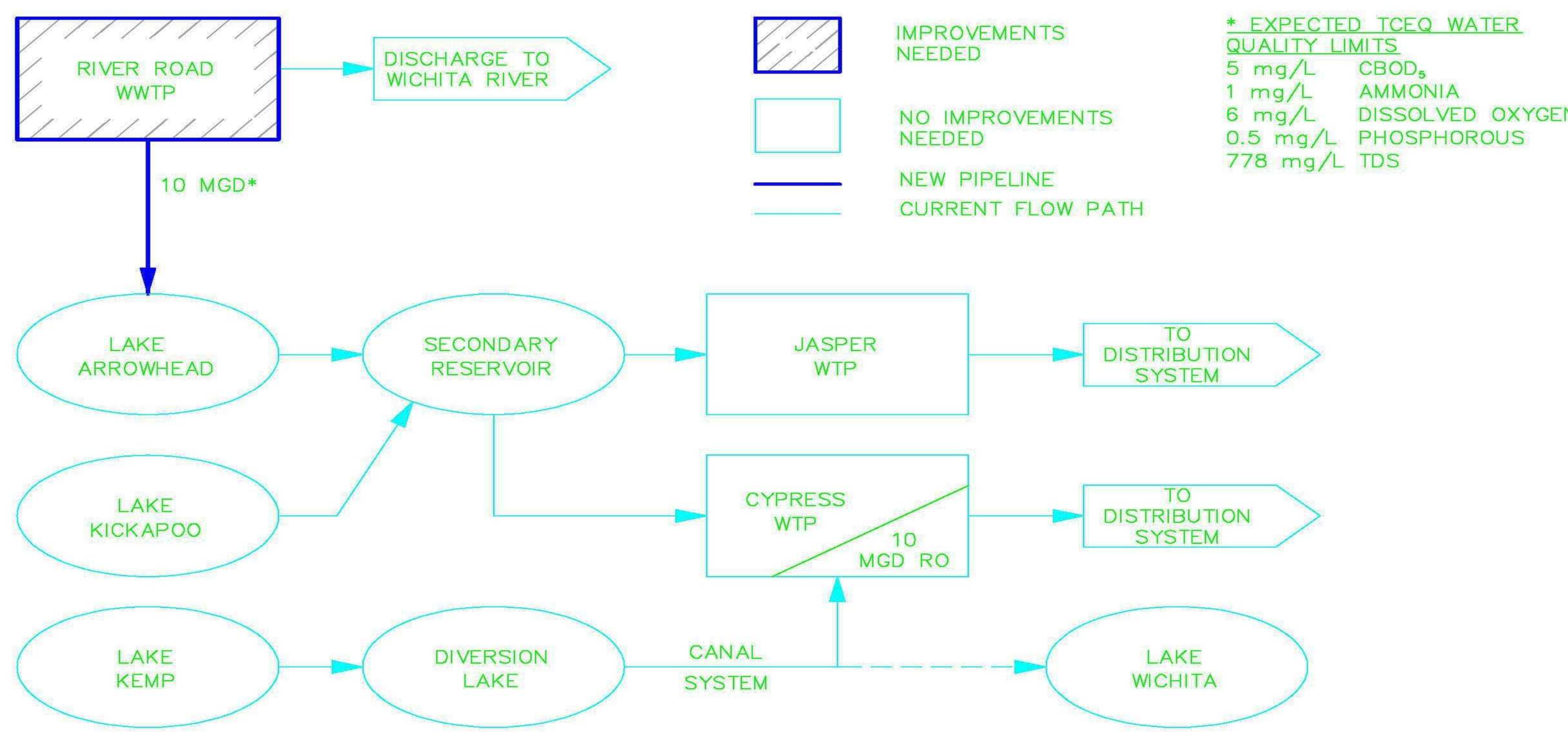
Direct Potable Reuse via Cypress WTP



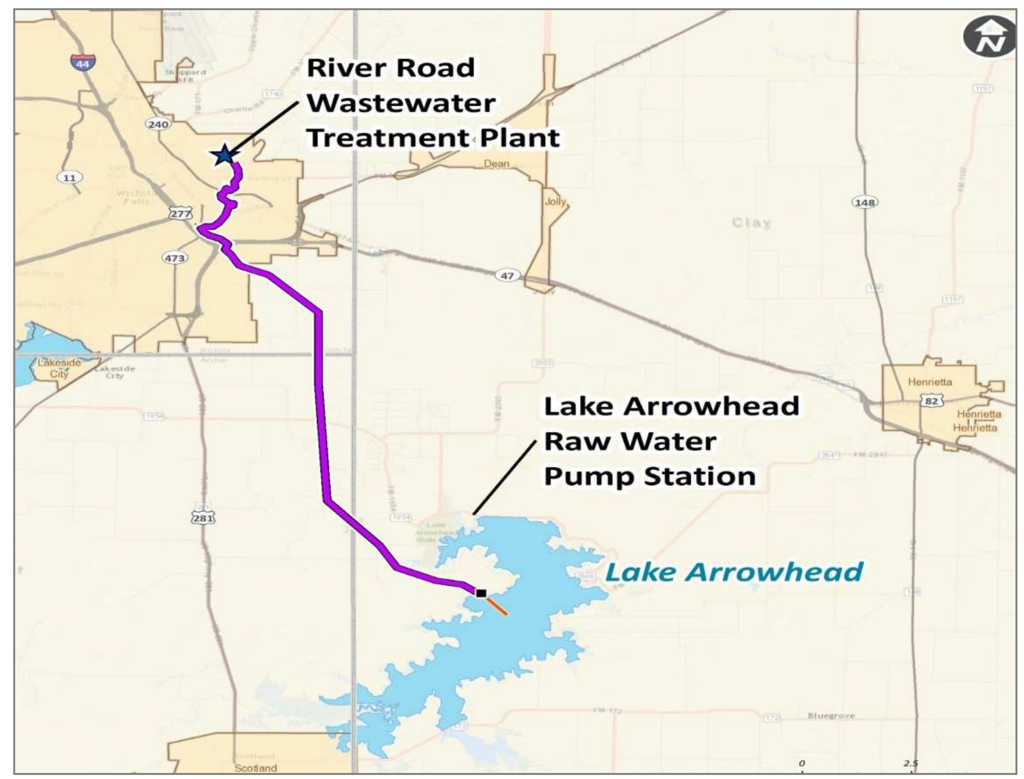
DPR Process Schematic



Indirect Potable Reuse via Lake Arrowhead



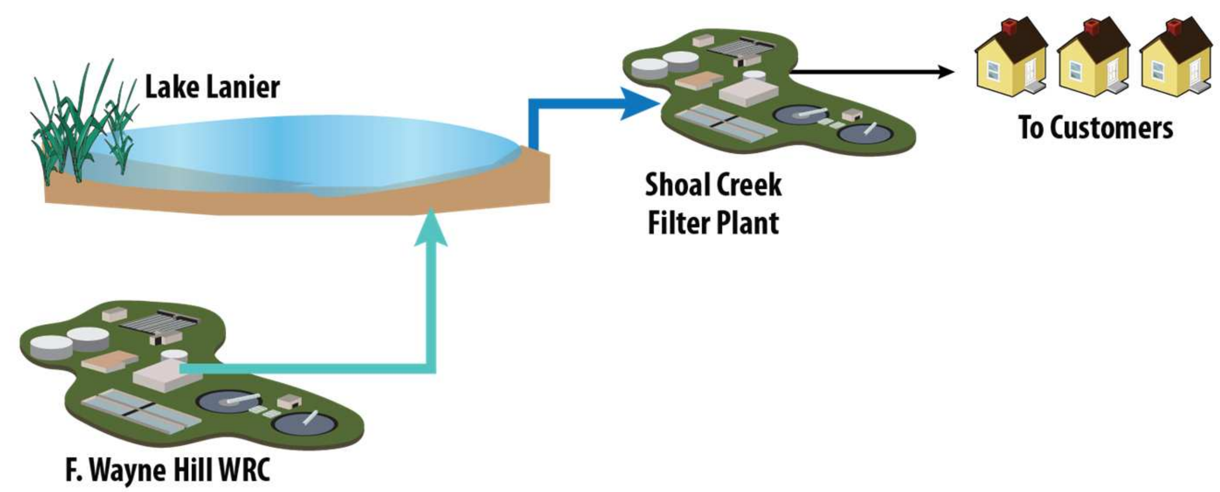
Indirect Potable Reuse Project



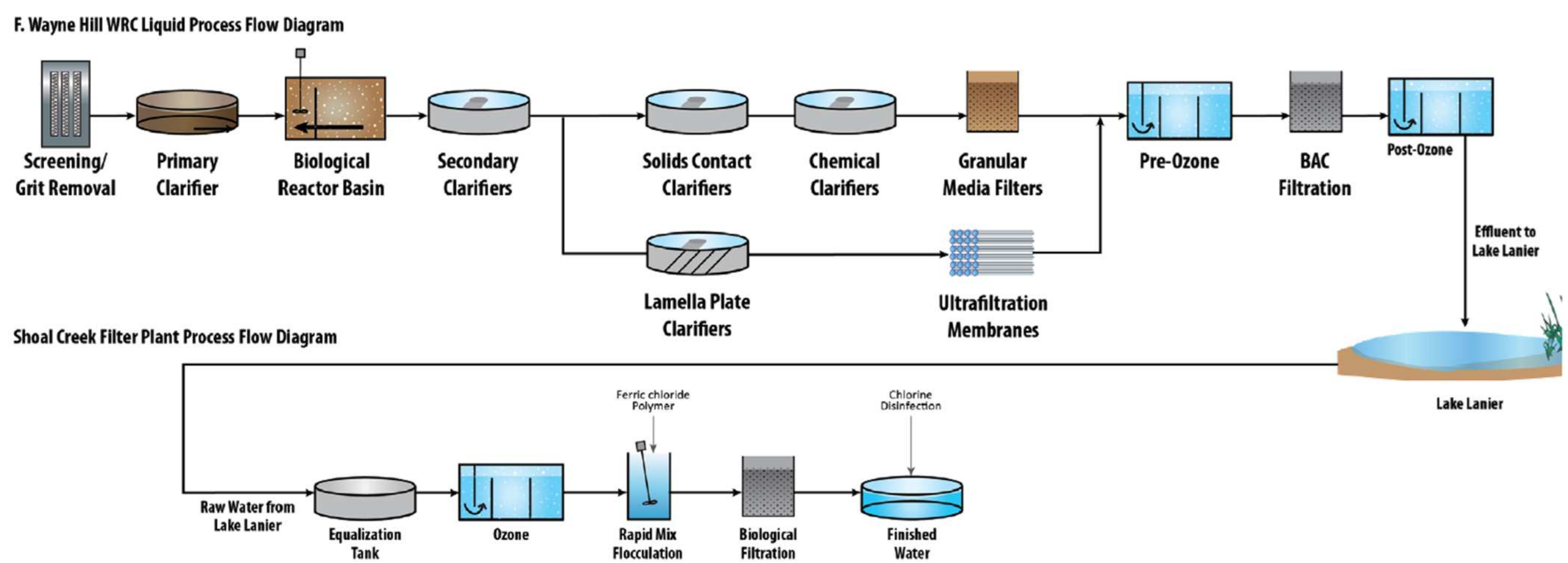
Gwinnett County, GA

Gwinnett County, Georgia

- Size: 60 mgd wastewater effluent discharged to Lake supplying 75 mgd plant
- Process:
  - Tertiary filtration, ozone, BAC, ozone
  - Ozone, filtration, chlorination
- Current Research
  - Pilot testing DPR using non-RO train
  - Evaluating process controls to ensure safety of product water



Current Treatment Trains



Water Quality Characterization – January 2016

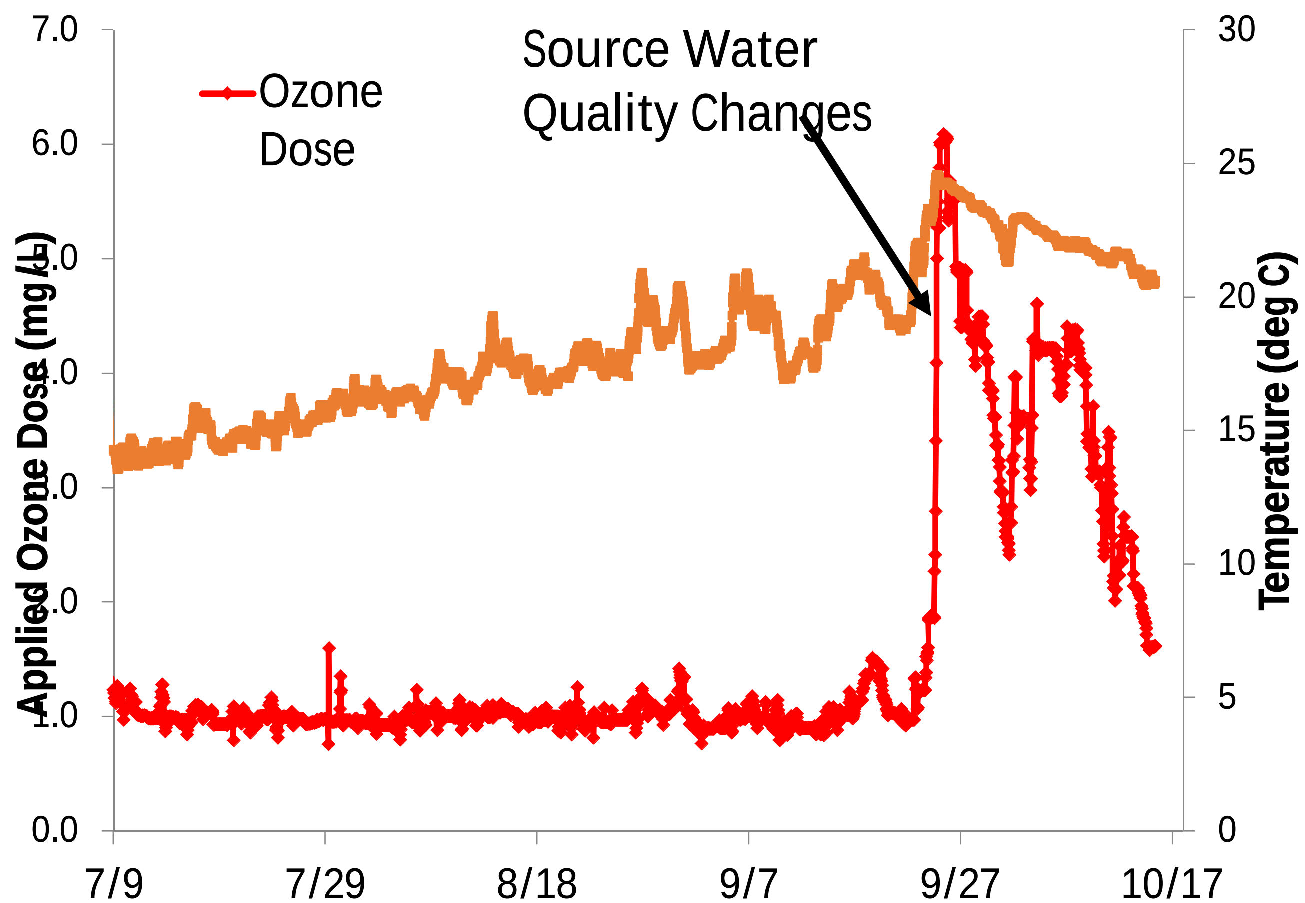
Water Quality	Lake Lanier Intake	F. Wayne Hill WRC Effluent
Temperature (deg C)	10	18.1
pH (SU)	5.73	6.38
ORP (mV)	588	160
Turbidity (NTU)	2.48	0.11
TOC (mg/L)	1.7	3.8
COD (mg/L)	<6	<6
TSS (mg/L)	6.4	0.70
Alkalinity (mg/L as $CaCO_3$)	19	69
Hardness (mg/L as CaCO3)	15	112
Bromide	0.09	0.016
Nitrite-Nitrate (mg-N/L)	0.31	15

Water Quality Characterization – January 2016

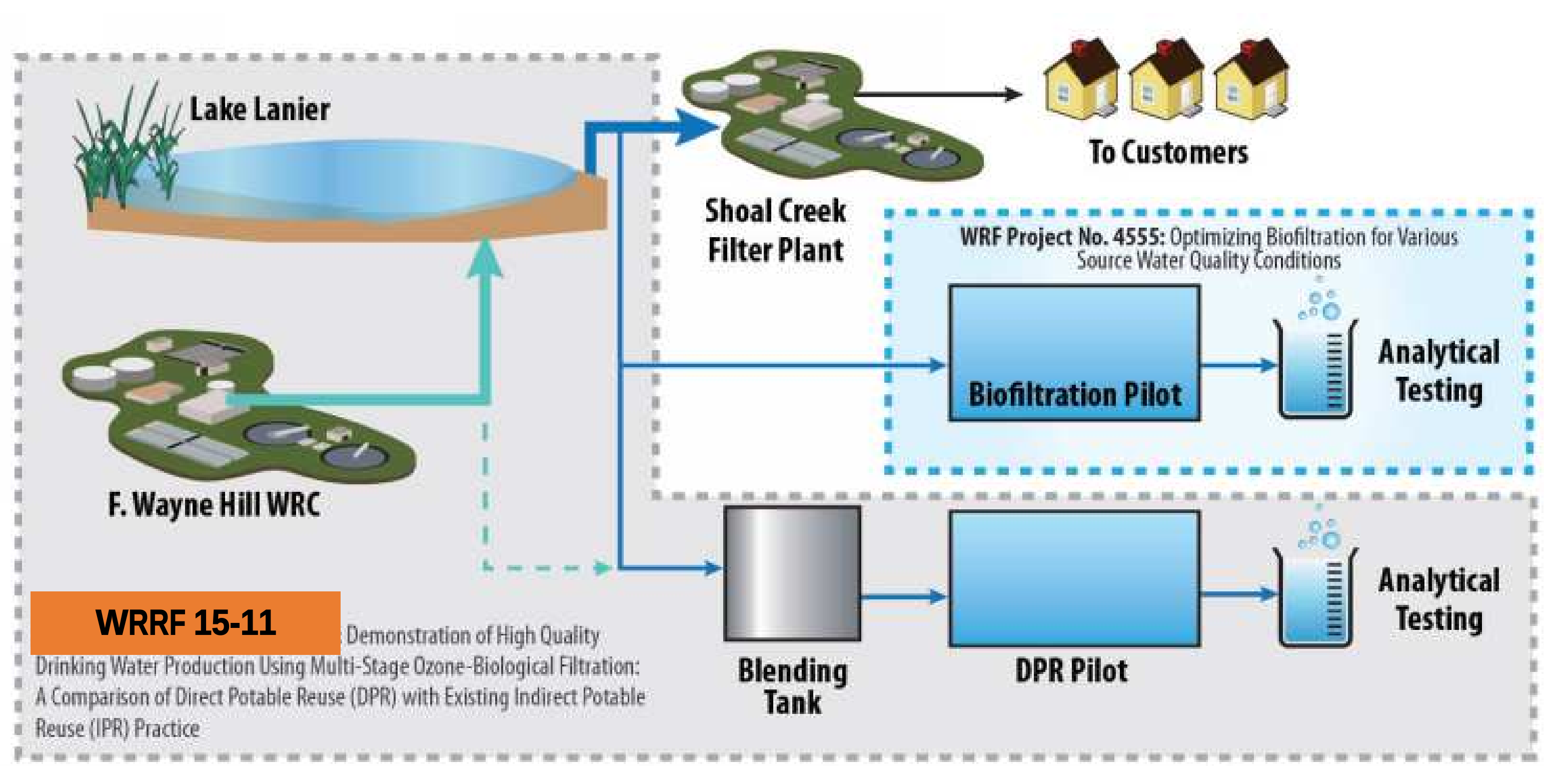
Water Quality	Constituent Category	Lake Lanier Intake	F. Wayne Hill WRC Effluent
4-nonylphenol (ng/L)	Consumer Product	<100	2,600
4-tert-Octylphenol (ng/L)	Consumer Product	<50	52
Acesulfame-K (ng/L)	Food Product	28	120
Iohexal (ng/L)	Pharmaceutical	22	410
Iopromide (ng/L)	Pharmaceutical	<5	22
Meclofenamic Acid (ng/L)	Pharmaceutical	<5	7.1
Simazine (ng/L)	Herbicide	11	5
Sucralose (ng/L)	Food Product	<100	13,000
TCEP (ng/L)	Flame Retardant	<10	120
TCPP(ng/L)	Flame Retardant	<100	340
TDCPP (ng/L)	Flame Retardant	<100	220

*table summarizes all measurements above the reporting limit using LC-MS-MS, ESI+ and ESI- mode; detection limits were 5, 10, or 20 ng/L for most analyses

Lake Turnover Water Quality Creates Operational Challenges

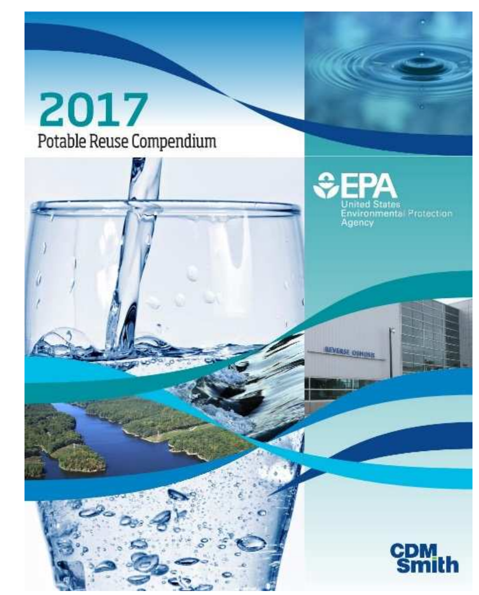


Pilot Testing of DPR to Improve Operation



Summary

- Water supply challenges are occurring for utilities across the US, often coupled with increasing requirements for wastewater discharge
- DPR and IPR already being successfully implemented throughout country
- Regulations for potable reuse being handled on state-by-state basis
- New EPA Potable Reuse Compendium supports states and utilities in development and management of potable reuse programs



https://www.epa.gov/ground-water-and-drinkingwater/potable-water-reuse-and-drinking-water

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CDM Smith

Questions & Comments

https://www.epa.gov/ground-water-and-drinkingwater/potable-water-reuse-and-drinking-water

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