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History and Prospects for Water Reuse in the U.S.

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Interdisciplinary Webinar "Wastewater Reuse in the United States and Australia: Obstacles and Solutions

April 15, 2021

You Asked That I Address Two Topics

1. What were the obstacles to wastewater reuse in the United States and how were they identified?
2. How were these obstacles addressed and to what extent were they addressed?

To Respond Let Me Make These Point

- Many Forms of Reuse are Available and Used
- Water Reuse is a Long-Term and Growin Practice in U.S.
- Water Reuse is Common, Even When Not Recognized
- Reuse is Becoming Recognized as Essential Component of Water Supply Portfolio in Many Locations
- Non-Potable Reuse is Widely Accepted and Practiced
- Potable Reuse is Practiced and is Becoming More Widely Accepted
- Technology is No Longer a Constraint to Water Reuse
- Acceptance of Water Reuse Depends on Non-Technical Factors

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Wide Range of Uses for Reclaimed Water Available

Category of Use	Specific Types of Use	Limitations
Landscape Irrigation	Parks, playgrounds, cemeteries, golf courses, roadway rights of way, school grounds, greenbelts, residential and other lawns	• Dual distribution system costs • Uneven seasonal demand • High TDS reclaimed water can adversely affect plant health
Agricultural irrigation	Food crops, fodder crops, fiber crops, seed crops, nurseries, sod farms, silviculture, frost protection	• Use of source are often some distance apart • High TDS reclaimed waer can adversely affect plant health
Non-potable urban uses (other than irrigation)	Toilet and uringal flushing, fire protection, air conditioner chiller water, commercial laundries, vehicle washing, street cleaning, decorative fountains and other water features	• Dual distribution system costs • Building level dual plumbing may be required • Greater burden on cross-connection control
Industrial Use	Cooling, boiler	based on proximity
Impoundments	Ornamental, recreational (including full-body contact)	• Dual distribution system costs • Nutrient removal required to prevent algal growth • ned water qualti and sensitivity of species
Environmental uses	Stream augmentation, marshes, wetlands	• Nutrient and ammonia removal may be required • Potential ecological impacts depending on reclaimed water quality and sensitivity of species
Groundwater recharge	Aquifer storage and recovery, seawater intrusion control, ground subsidence control	• Appropriate hydrogeological conditions needed • High level of treatment may be required
Potable water supply augmentation	Water su	• Requires post-treatment storage • Can be energy intensive
Miscellaneous	Aquaculture, snow making, soil copaction, dust control, equipment washdown, livestock wering	

Removal of Biodegradable Organics and Disinfection

Removal of Biodegradable Organics and Disinfection Plus TDS

Removal of Biodegradable Organics and Disinfection Plus Nutrients

Removal of Biodegradable Organics and Disinfection Plus Trace Constituents

US National Academies, 2012, Table 2.2

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Illustrated by Potable Water Reuse History

Table 1.7. Treatment Technologies Employed at Operational Potable Reuse Plants

Project	Geographic Location	Type of Potable Reuse	Year First Operational	Capacity	Current Advanced Treatment Process
Montebello Forebay, Sanitation Districts of Los Angeles County, CA	Coastal	Groundwater recharge via spreading basins	1962	44 mgd (167 mld)	GMF + Cl_2 + SAT (spreading basins)
Windhoek, Namibia	Inland	Direct potable reuse	1968	5.5 mgd (21 mld)	O_3 + Coag + DAF + GMF + O_3/H_2O_2 + BAC + GAC + UF + Cl_2 (process as of 2002)
Upper Occoquan Service Authority,Centreville,VA	Inland	Surface water augmentation	1978	54 mgd (204 mld)	Lime + GMF + GAC + Cl_2
Hueco Bolson Recharge Project, El Paso, TX	Inland	GW recharge via direct injection and spreading basins	1985	10 mgd (38 mld)	Lime + GMF + Ozone + GAC + Cl_2
Clayton County Water Authority, GA	Inland	Surface water augmentation	1985	18 mgd (68 mld)	Cl_2 + UV disinfection + SAT (wetlands)
West Basin Water Recycling Plant, CA	Coastal	GW recharge via direct injection	1993	12.5 mgd (47 mld)	MF + RO + UVAOP
Scottsdale Water Campus, AZ	Inland	GW recharge via direct injection	1999	20 mgd (76 mld)	MF + RO + Cl_2
Gwinnett County, GA	Inland	Surface water augmentation	2000	60 mgd (227 mld)	Coag/floc/sed + UF + Ozone + GAC + Ozone
NEWater, Singapore	Coastal	Surface water augmentation	2000	146 mgd (5 plants)	MF + RO + UV disinfection
Los Alamitos Seawater Intrusion Barrier, Long Beach, CA	Coastal	GW recharge via direct injection	2006	3.0 mgd (11 mld)	MF + RO + UV disinfection
Chino Basin Groundwater Recharge Project, Chico, CA	Inland	GW recharge via spreading basins	2007	18 mgd (68 mld)	GMF + Cl_2 + SAT (spreading basins)
Groundwater Replenishment System, Orange County, CA	Coastal	GW recharge via direct injection and spreading basins	2008	70 mgd (265 mld)	MF + RO + UVAOP + SAT (spreading basins for a portion of the flow)
Western Corridor Recycled Water Scheme; Queensland, Australia	Coastal	Surface water augmentation	2009	66 mgd via three plants (250 mld)	MF + RO + UVAOP
Cloudcroft, NM	Inland	Direct potable reuse through spring water augmentation	2009	0.1 mgd (0.4 mld)	MF + RO + UVAOP
Arapahoe County/Cottonwood, CO	Inland	GW recharge via spreading	2009	9 mgd (34 mld)	SAT (via RBF) + RO + UVAOP
Big Spring Reclamation Project; TX	Inland	Direct potable reuse through raw water blending	2013	1.8 mgd (6.8 mld)	MF + RO + UVAOP

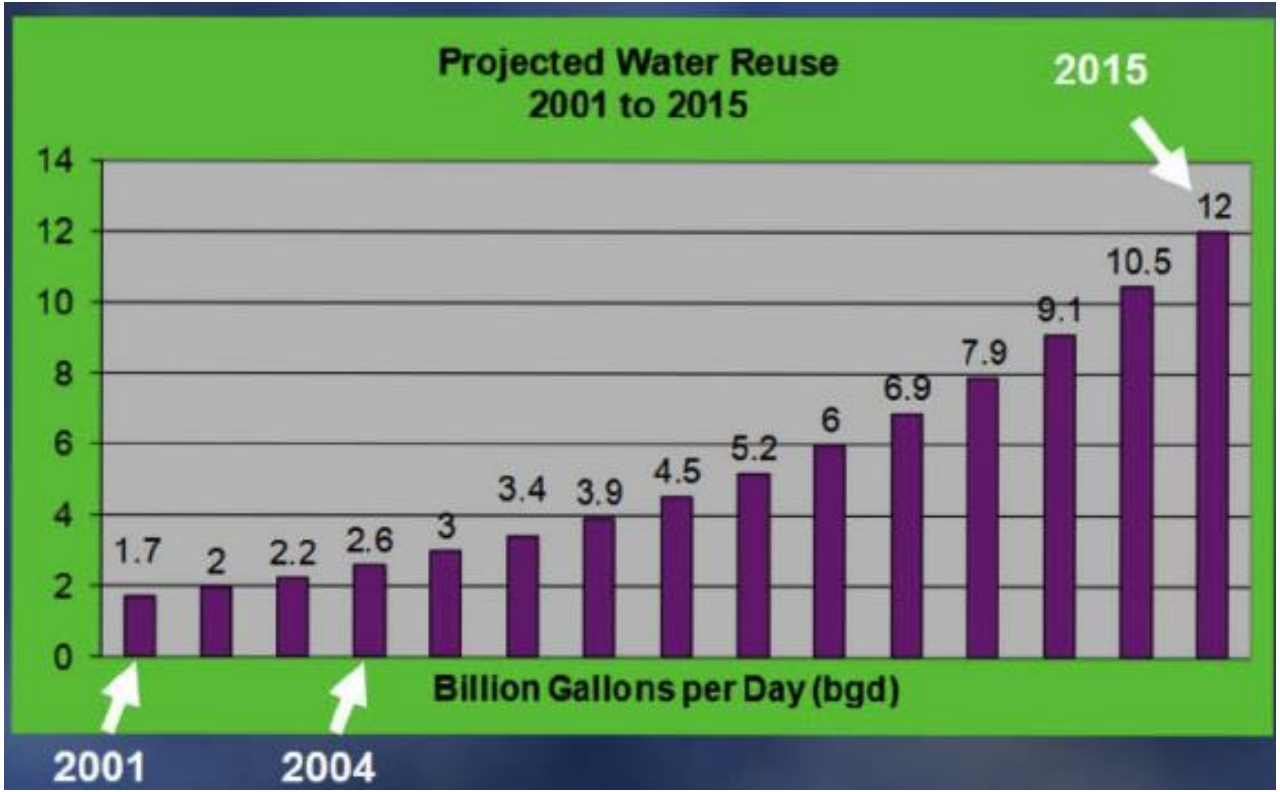
Source: Adapted from Drewes and Kahn (2010); Asano et al. (2007)

Notes: ARR = Aquifer Recharge and Recovery; BAC = Biological Activated Carbon filtration; Cl_2 = Chlorine Disinfection; Coag = Coagulation; DAF = Dissolved Air Flotation; GAC = Granular Activated Carbon; GMF = granular media filtration; GW = groundwater; H_2O_2 = Hydrogen Peroxide; MF = Microfiltration; O_3 = Ozone; RBF = riverbank filtration; RO = Reverse Osmosis; SAT = Soil Aquifer Treatment; UF = Ultrafiltration; UV = Ultraviolet; UVAOP = UV Advanced Oxidation Process

- First Recorded Installation 1962
  - California Groundwater Recharge
- Increasing Pace of Application with Growing Acceptance
- Technology Varies with Location
  - Coastal vs. Inland

Schimmoller and Kealy, 2014

Water Reuse Growing Exponentially in U.S.



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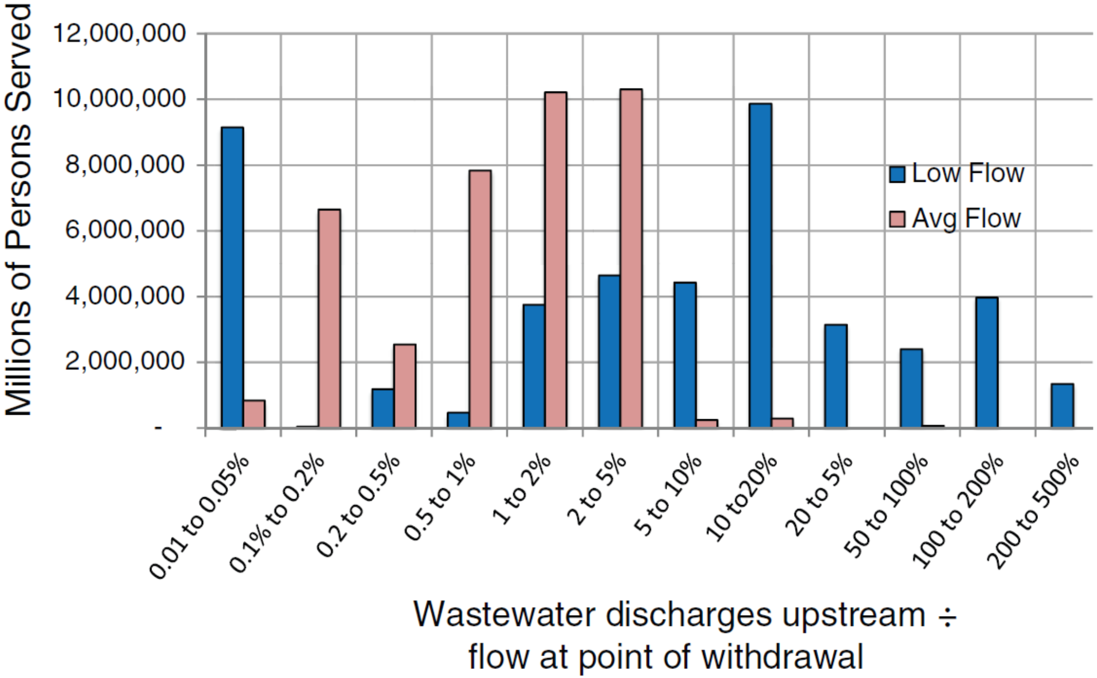
In Fact, deFacto Water Reuse is Ubiquitous

Trinity River Basin, showing Dallas/Fort Worth in the headwaters of the water supply for the city of Houston.
SOURCE: http://wapedia.mobi/en/File:Trinity_Watershed.png.



Persons served by a water supply with wastewater content according to EPA's 1980 survey of wastewater discharged upstream of drinking water intakes.
SOURCE: Data from Swayne et al. (1980).

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Why is Reuse Essential Component of Portfolio?

- Portfolio Approach to Drought-Proofing Water Supplies Becoming Well Accepted:
  - Reuse is Proven Component of Such Systems
- Superior Economics for Reuse Compared to Other, Similar Options
  - Desalination
- More Complete Wastewater Treatment (BNR) Becoming Widely Applied
- Relevant Management/Monitoring Procedures Well Proven:
  - Source Control to Manage Industrial and Commercial Discharges
  - Advanced Water Quality Monitoring to Assure Quality Control
- Methodologies for Outreach to Gain Public Support are Becoming More Well Developed and Can be More Successfully Applied

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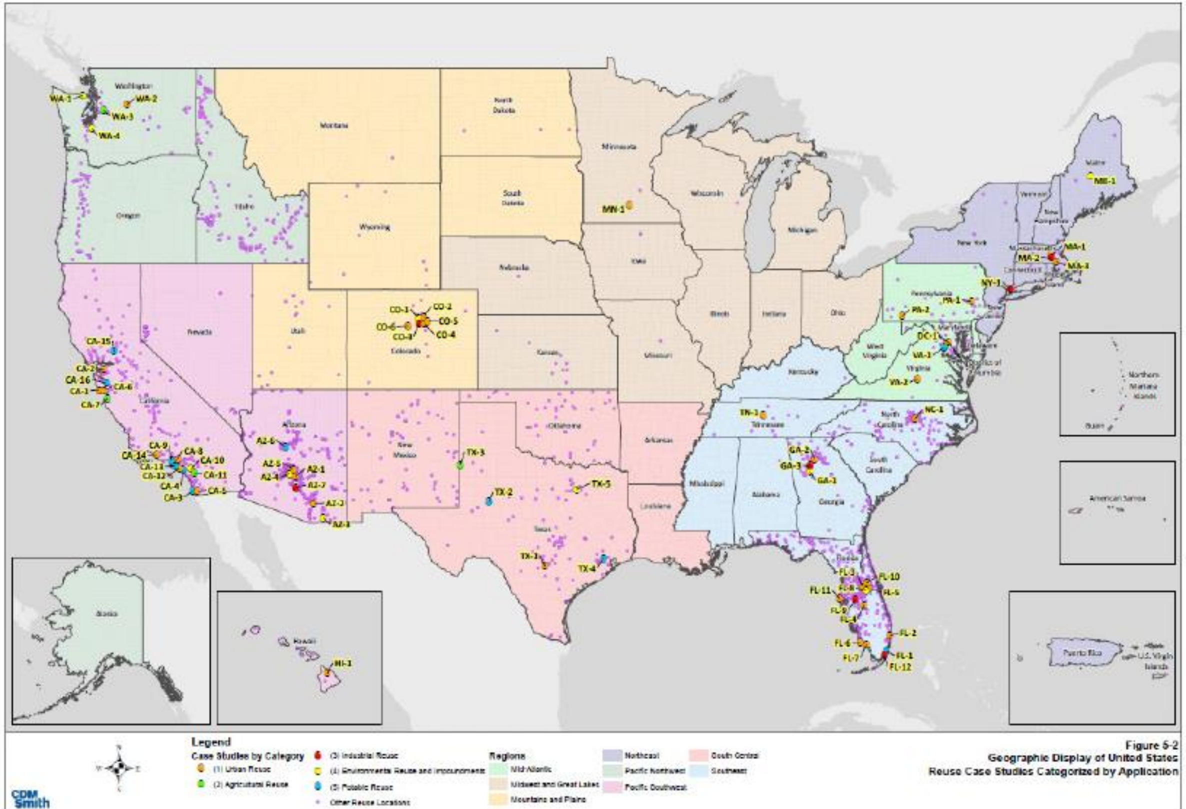
U.S. Reuse Projects



USEPA, 2012

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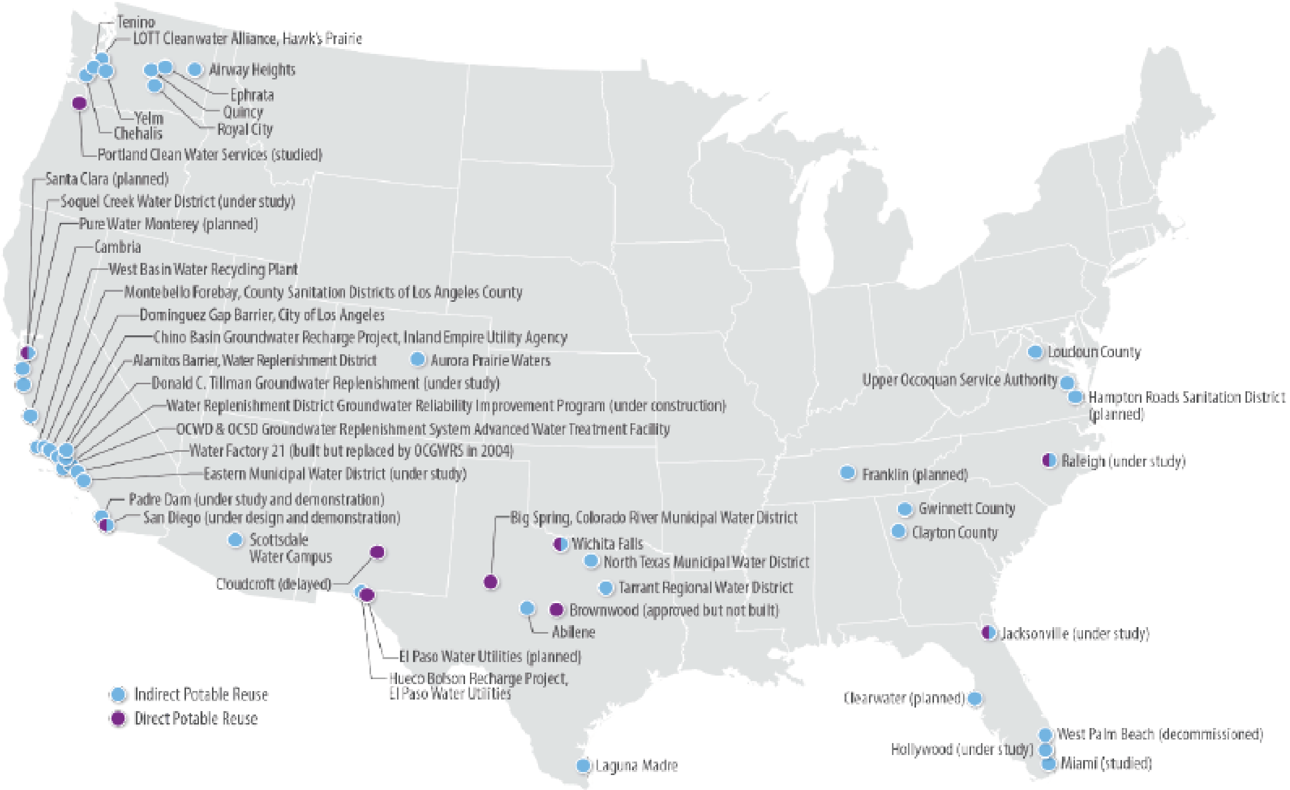
Current and Planned Potable Reuse Projects in U.S.



USEPA, 2017

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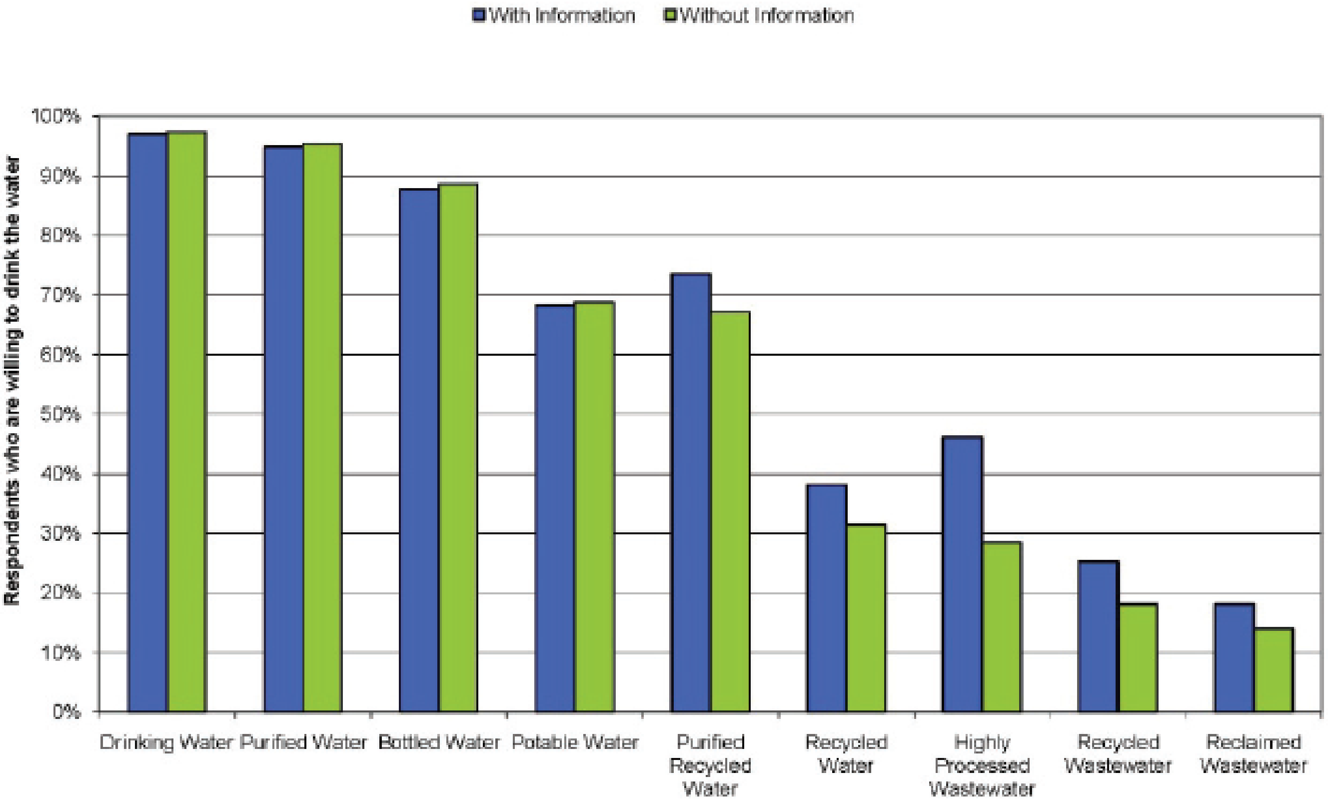
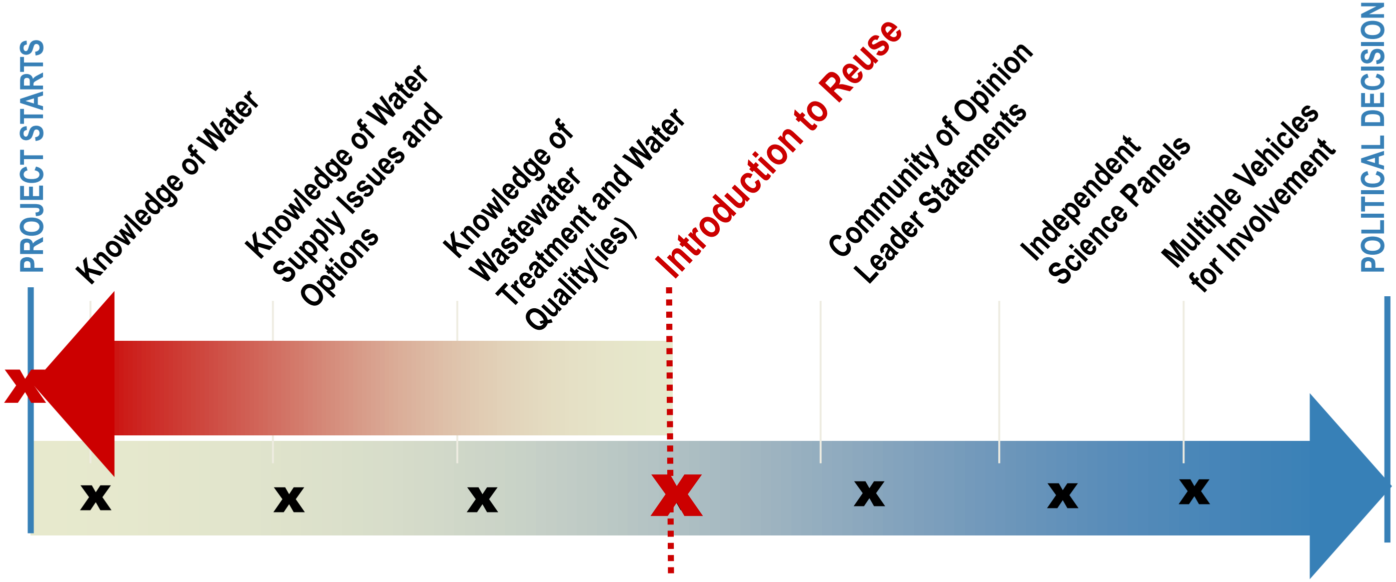
Using the Appropriate Words is Crucial for Public Acceptance



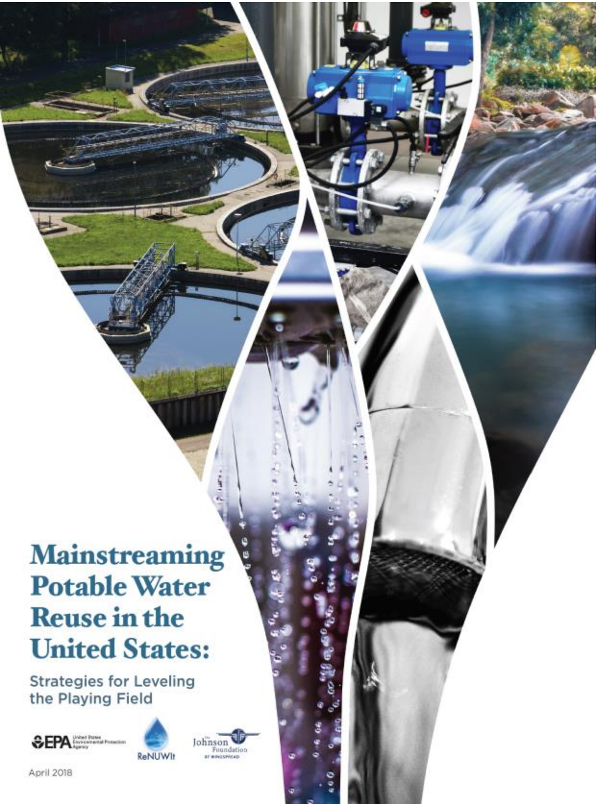
WRF-07-03, 2011

Discussions on REUSE typically start here…

…when they actually need to start HERE!



Recommendations From 2018 Study Can Guide Implementation



- Assess the utility's reputation among customers and decision makers before investing in project planning;
- Create and execute a comprehensive strategic communication, outreach, and involvement strategy to build trust and credibility (and consider enlisting the assistance of a communications consultant);
- Use an external expert body to advise on the design and implementation, and support monitoring and evaluation of projects (especially in places where potable water reuse is still perceived as a novel practice);
- Assess the community needs driving consideration of a project, articulate how a project responds to those needs, and how different stakeholders may be impacted;
- Take an integrated water management approach, understand the motivating drivers, and be prepared to navigate applicable governance structures that will influence development of a project;
- Develop a comprehensive financing plan that considers community interests, long-term capital improvement and asset management needs, as well as alternative financing mechanisms;
- Work actively with state primacy agencies to establish workable regulatory approaches that are protective of public health;
- Introduce potable water reuse as a potential water supply option early in state-wide or local water planning processes;
- Foster collaboration and integration among drinking water and wastewater utilities through watershed-based integrated resource management processes;

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You Asked That I Address Two Topics

1. What were the obstacles of wastewater reuse in the United States and how were they identified?
   a. Institutional Capacity to Successfully Implement Reuse Systems
   b. Public Perception of "Pristine" Water Supplies
2. How were these obstacles addressed and to what extent, they were addressed?
   a. Water Reuse Undertaken by Competent Utilities That Were also Competent Actors Withing Their Communities
   b. Effective Communication with Public Using Proper Language Over Extended Period of Time

Some Key References

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