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Balancing Risk Assessment and Life Cycle Analysis of Water Reuse Approaches

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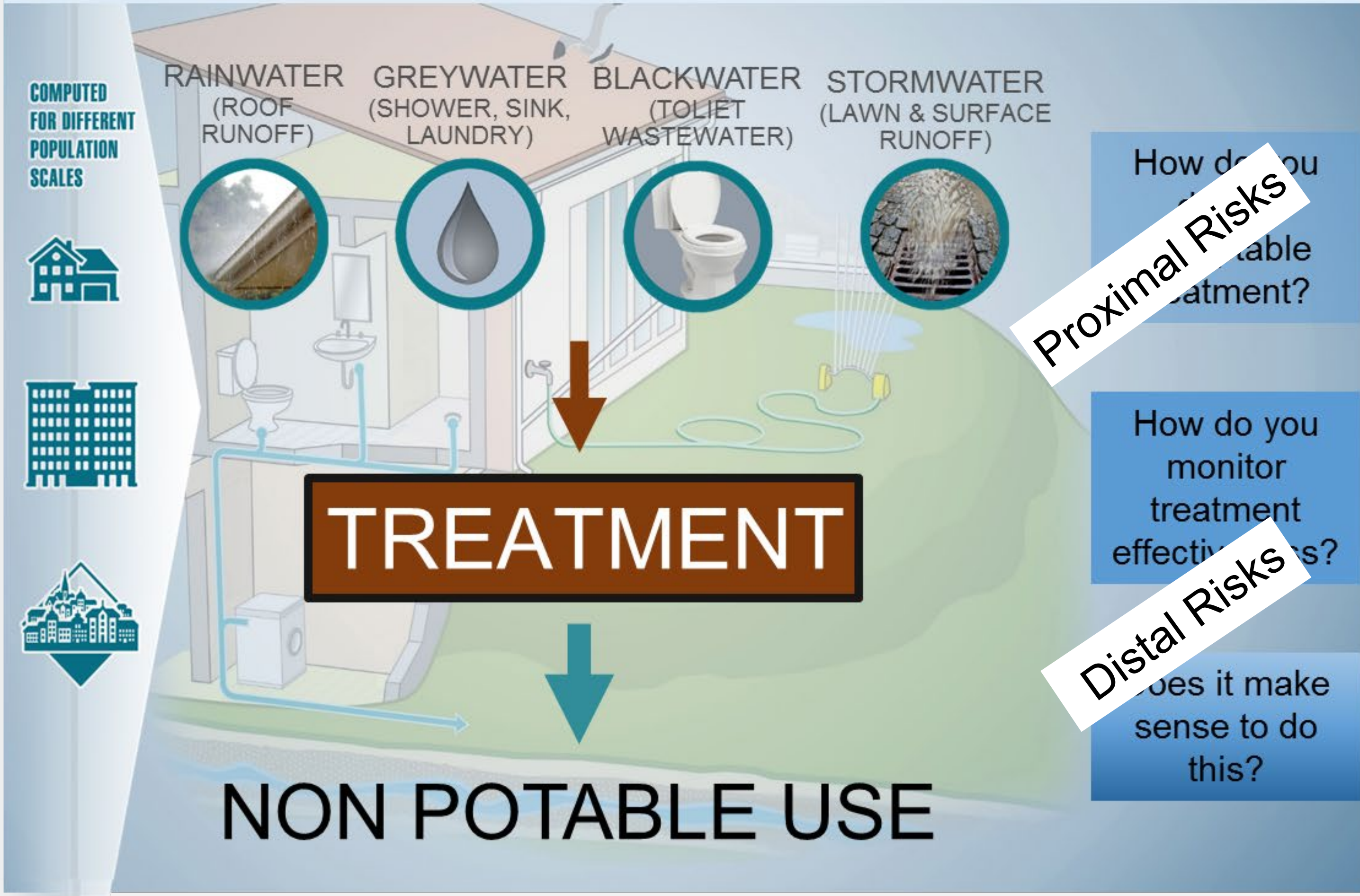
FINDING NEW WATER Alternative Water Reuse



Partners

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

National Blue Ribbon Commission for Onsite Non-potable Water Systems

WATER ENVIRONMENT & REUSE FOUNDATION WE&RF

US Water Alliance

Report

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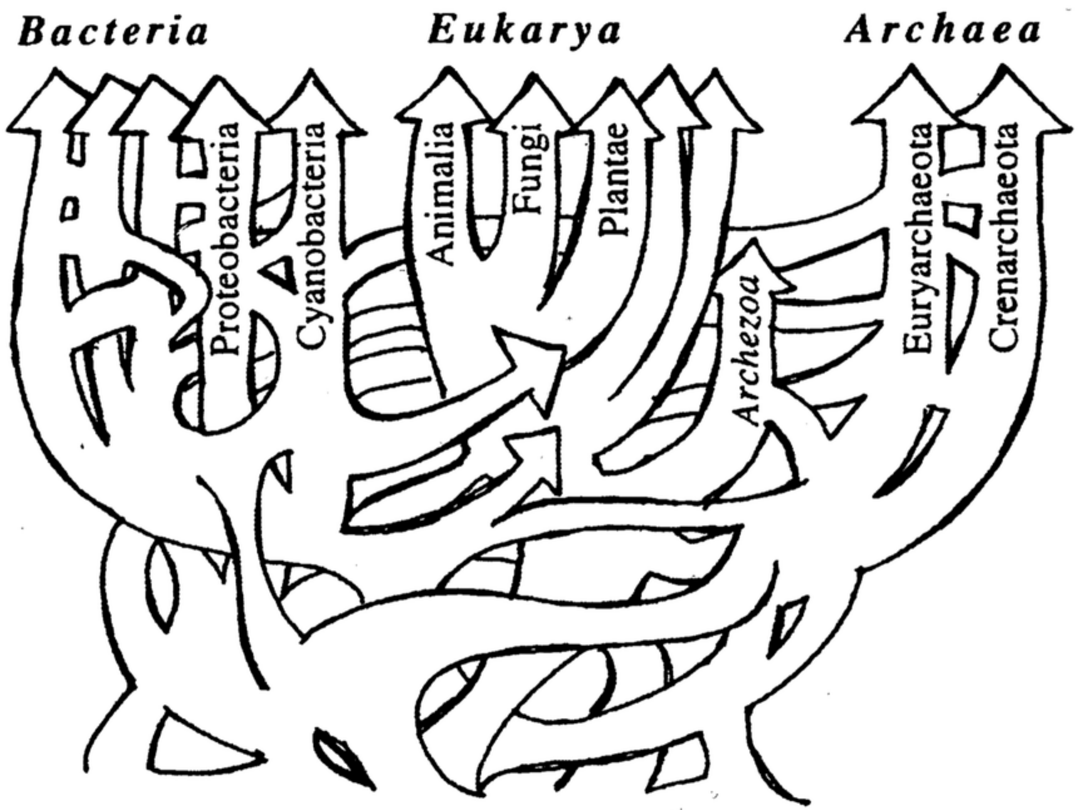
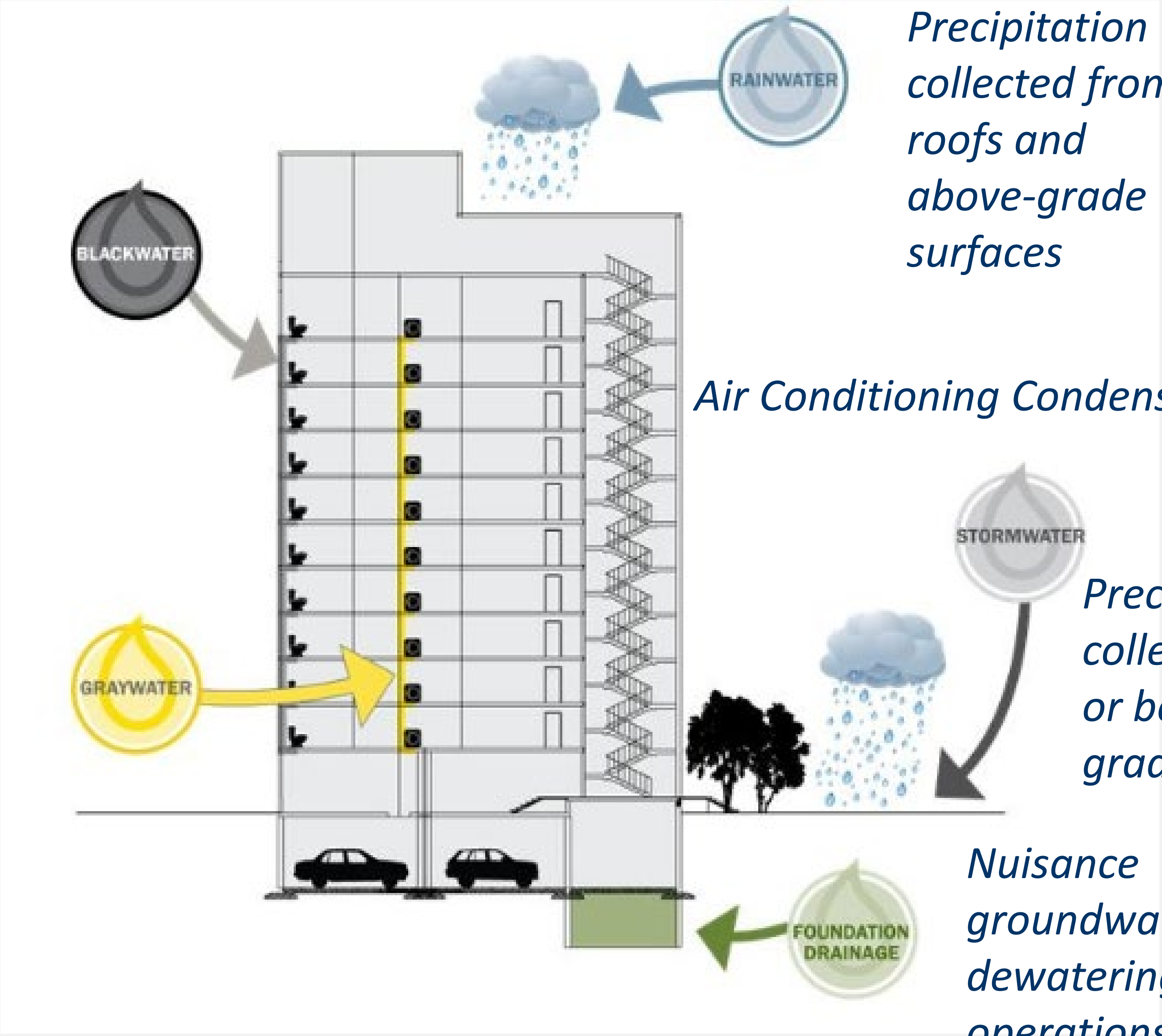


Ford Doolittle's Reticulated Tree Of Life

Buildings Produce Water

Wastewater from toilets, dishwashers, kitchen sinks, and utility sinks

Wastewater from clothes washers, bathtubs, showers, and bathroom sinks



Precipitation collected from roofs and above-grade surfaces

Air Conditioning Condensate

Precipitation collected at or below grade

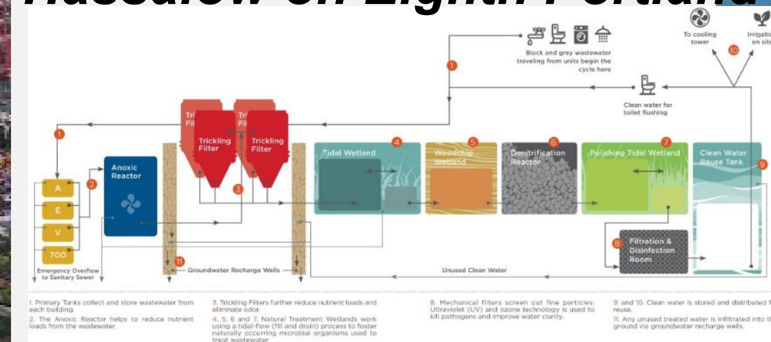
Nuisance groundwater from dewatering operations

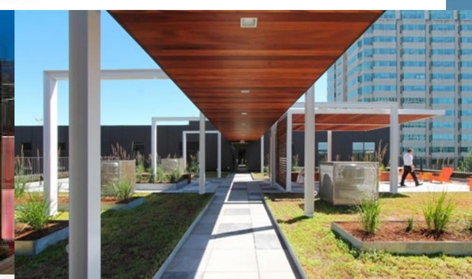
Increasing Building Scale Reuse Across US

The Solaire, Battery Park, NYC

25,000 gpd of wastewater
Membrane Bioreactor
Toilet Flushing, cooling, irrigation

Hassalow on Eighth Portland





60,000 gpd wastewater
Treatment includes landscaping
Toilet Flushing, cooling, irrigation

181 Fremont, San Francisco

5,000 gpd greywater
Membrane bioreactor
Toilet flushing

gpd - gallons per day

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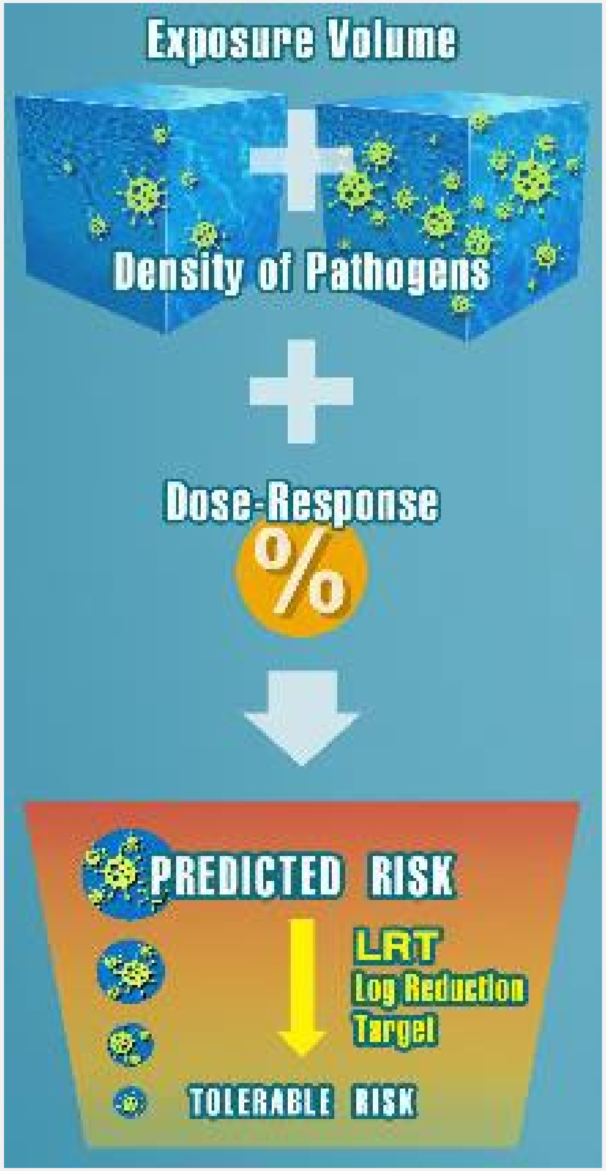
Quantitative Microbial Risk Assessment



“Source” Waters

(roof runoff, stormwater, graywater, blackwater)

End Use

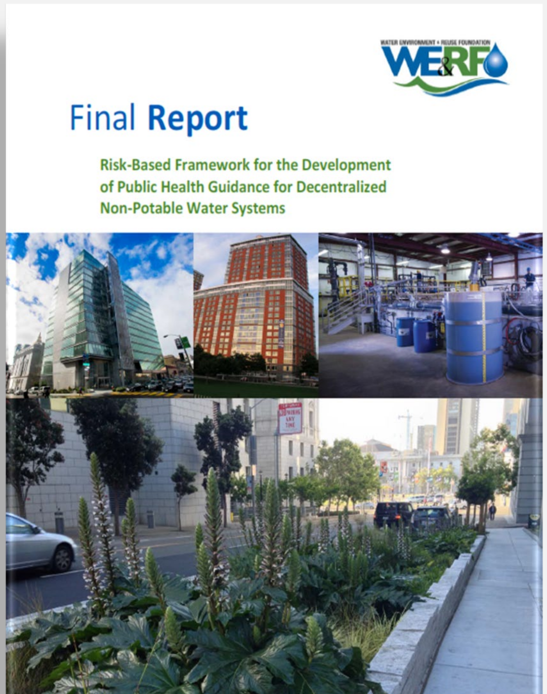
Non-Potable

Potable

A Structured Framework

Transparent underlying assumptions

Flexible and Adaptable



Water Use Scenario	Log10 Reduction Targets for 10^{-4} (10^{-2}) Per Person Per Year Benchmarks[b,i]		
	Enteric Viruses[c]	Parasitic Protozoa[d]	Enteric Bacteria[e]
Domestic Wastewater or			

Risk-based approach increasingly adopted

Colorado, California, Washington

Austin, San Francisco

Or actively considered

Oregon, Hawaii, Arizona

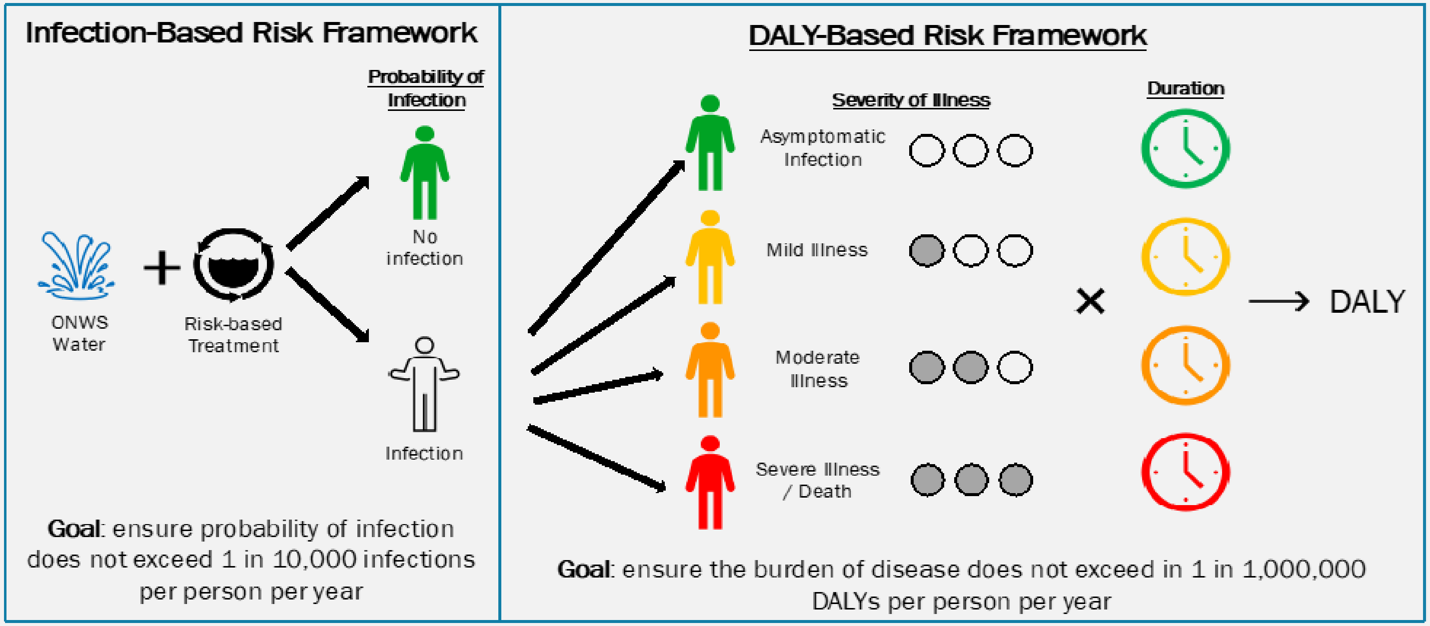
Potential integration with building codes

ICC, IAPMO, NSF

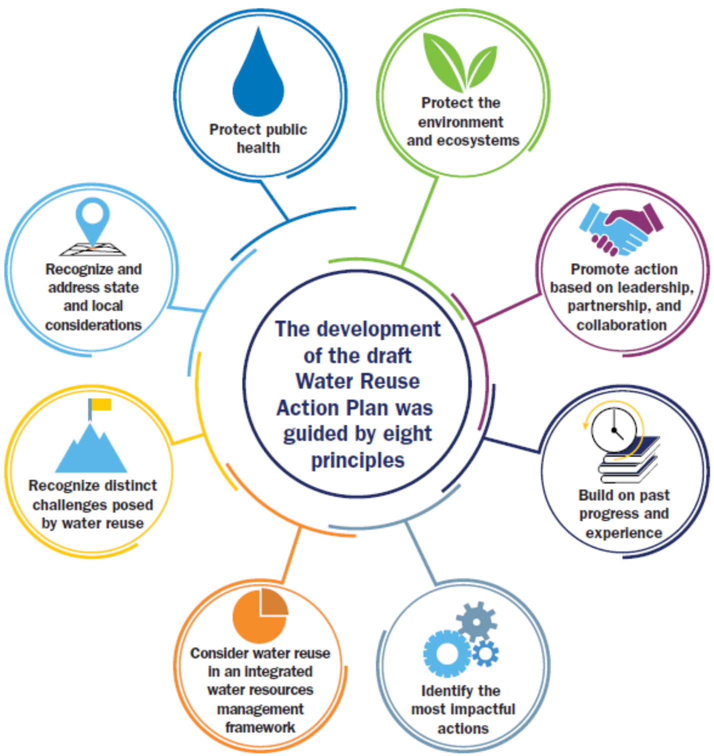
Sharvelle et al. (2017) Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems
Schoen et al. (2017) Microbial Risk Analysis 5, 32-43

Recent Efforts Resulting in Different LRTs (NBRC)

Source Water	Virus[1]				Protozoa					Bacteria			
	2017	CA	DALY	2022	2017	CA (*Giardia*)	CA (*Crypto*)	DALY	2022	2017	CA	DALY	2022
Onsite Wastewater	8.5	8.0	10.0	11.5	7.0	6.5	5.5	6.5	7.0	6.0	n/a	5.5	7.5
Graywater	6.0	6.0	7.5	9.0	4.5	4.5	3.5	4.0	4.5	3.5	n/a	3.5	5.5
Stormwater (10^{-1} dilution)	5.5	7.0	8.0	9.5	5.5	5.5	4.5	6.0	6.5	5.0	n/a	5.5	6.5
Stormwater (10^{-3} dilution)	3.5	n/a	6.0	7.5	3.5	n/a	n/a	4.0	4.5	3.0	n/a	3.5	4.5
Stormwater (10^{-4} dilution)	n/a	n/a	5.0	6.5	n/a	n/a	n/a	3.0	3.5	n/a	n/a	2.5	3.5
Roof Runoff	n/a	n/a	n/a	n/a	n/a	1.5	n/a	1.0	2.0	3.5	n/a	3.5	5.0



Guiding Principles of the Water Reuse Action Plan

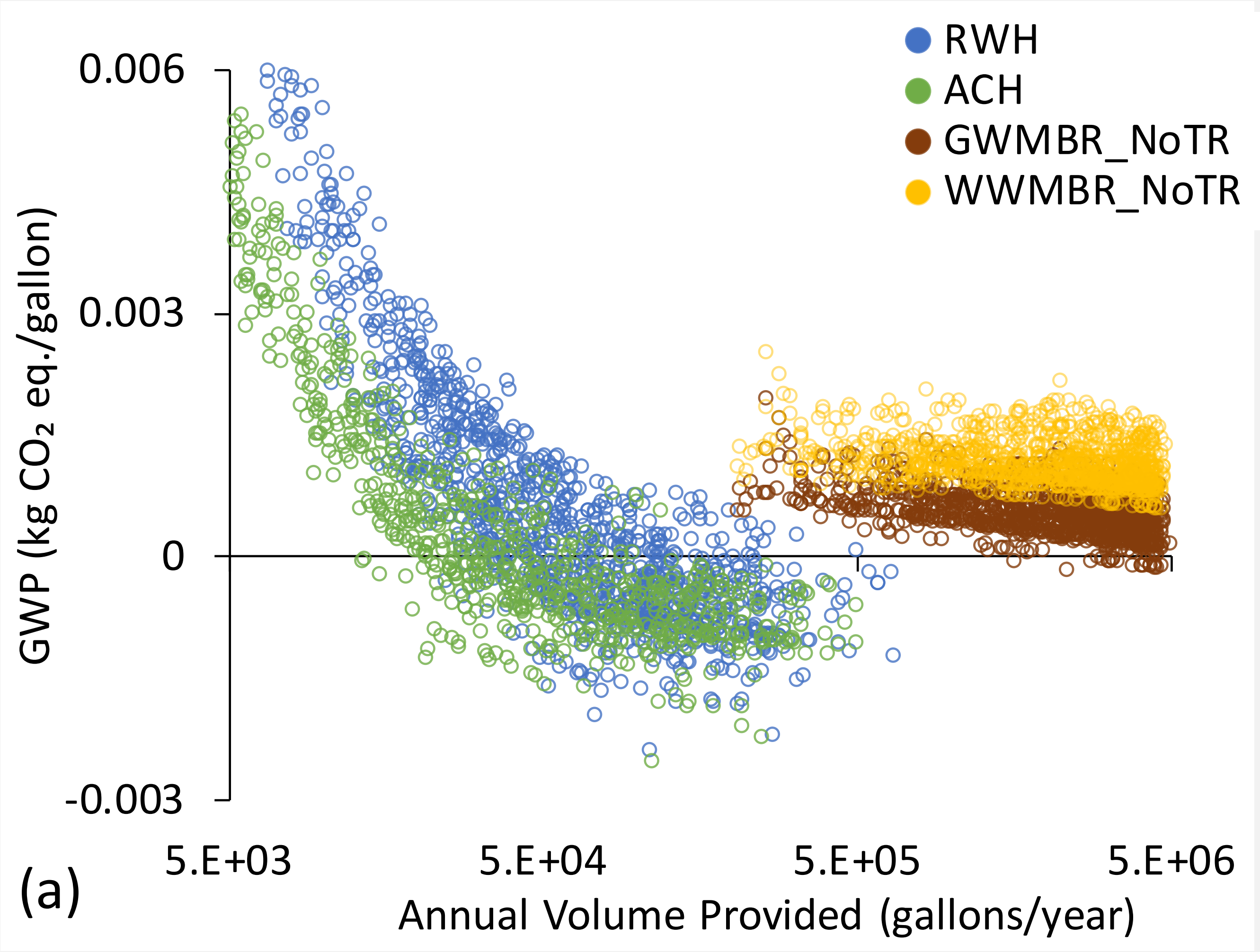


Source: www.epa.gov/sites/production/files/2019-09/documents/water-reuse-action-plan-draft-2019.pdf

Does it make sense to do this?

- Avoid burden-shifting with respect to economic and environmental impacts
- System level assessment of decentralized systems, including impacts on existing centralized infrastructure?

Global Warming Potential Across Source Waters, Variable Location and Building Characteristics



- 50-1,100 occupants
- 10-20 ft²/occupant (500-22,000 ft²)
- 2-20 floors

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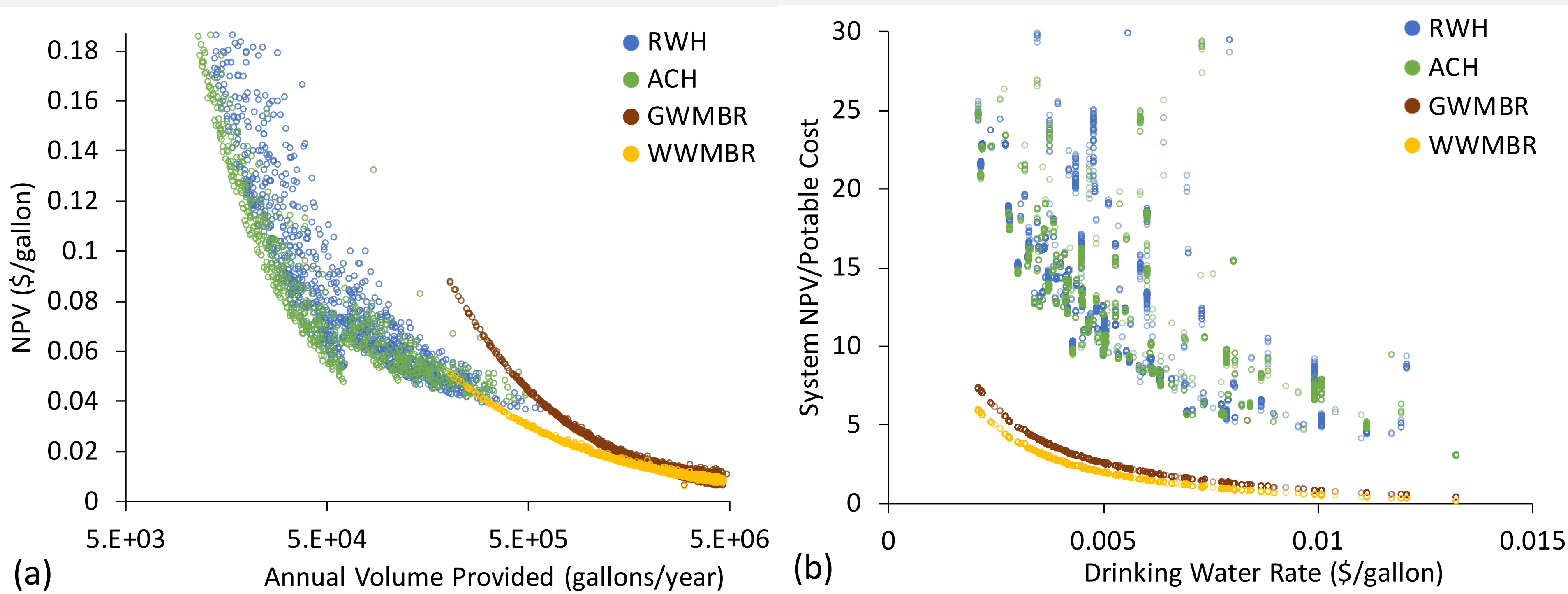
Net Present Value Across Source Waters, Variable Location and Building Characteristics



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Research Gaps

- **Risks Assessment**
  - Improve data on contaminant levels in alternative source waters to improve risk models
  - Define unit process based removal rates to optimize system design
    - Methods/surrogates to reflect infective virus removal
    - Grouping based approaches to chemicals (analogous to microorganisms))
  - Assess fit for purpose health risk benchmarks
    - E.g., household based, occupational exposures
    - Broader (and more distal) impacts of alternative water systems
- **Systems Analysis**
  - Expand screening level cost and impact assessment tools to help inform decision making
  - Leverage data from early adopters of alternative water systems to improve fidelity of life cycle models and refine system designs
  - Translate life cycle impacts to health impacts for linkage to risk assessment (e.g., DALYs, dollars)

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