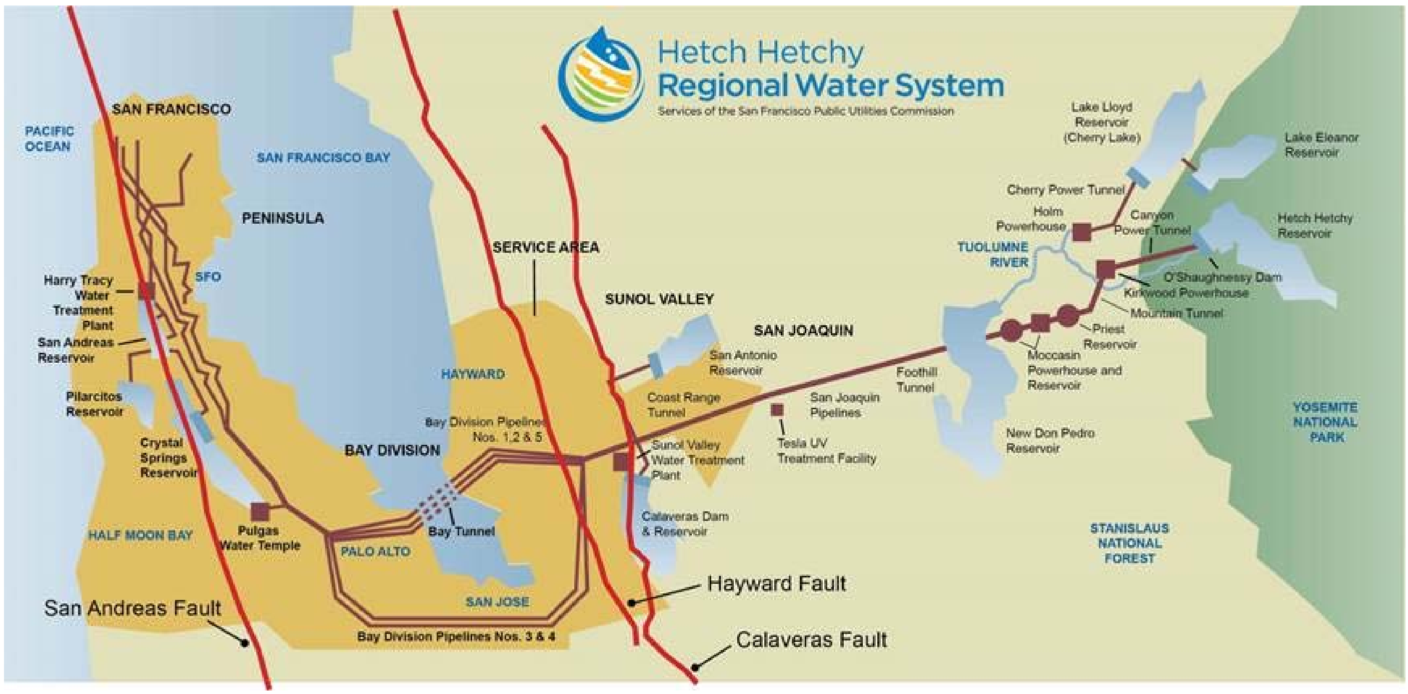
PureWaterSF

Direct Potable Reuse Demonstration in San Francisco

Manisha Kothari, Project Manager
San Francisco Public Utilities Commission

Andrea F. Corral, Lead Technologist
Carollo Engineers, Inc.

San Francisco Water Supplies



- San Francisco has historically relied on the Regional Water System
- Since 2008, the SFPUC has begun to diversify and implement traditional and non-traditional alternative water supplies

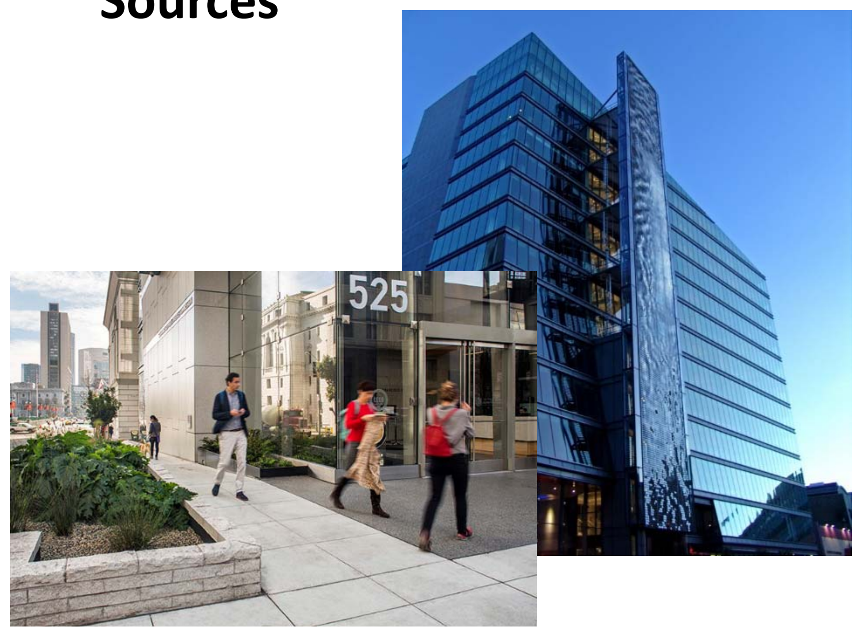
Diversifying Water Supplies in SF

Traditional Alternative Sources

Recycled water irrigation at Harding Park Golf Course

Groundwater

Non-Traditional Alternative Sources

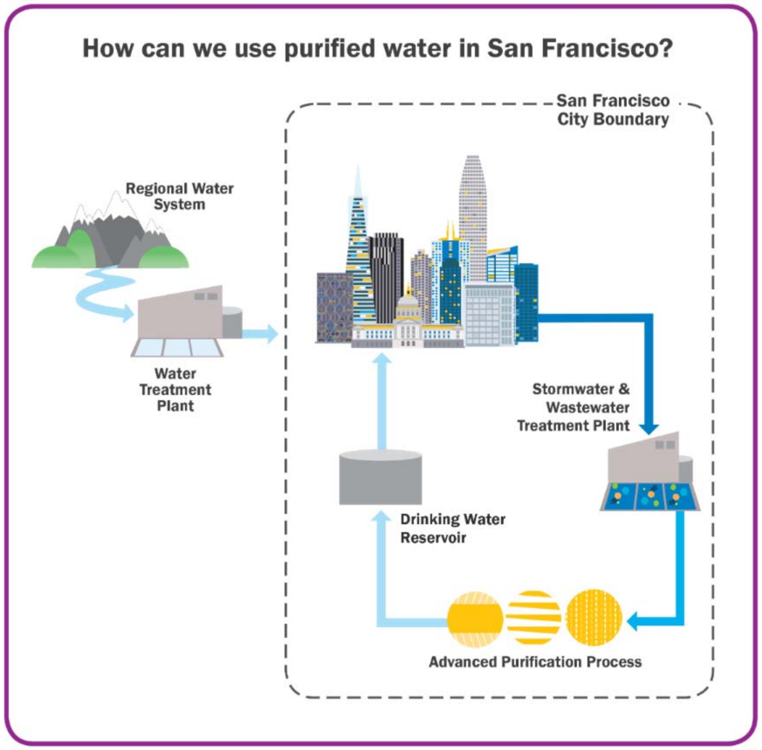


Diversifying Water Supplies in SF

Our Next Step:

Begin the process of evaluating the feasibility of direct potable reuse as part of San Francisco's water supply portfolio.

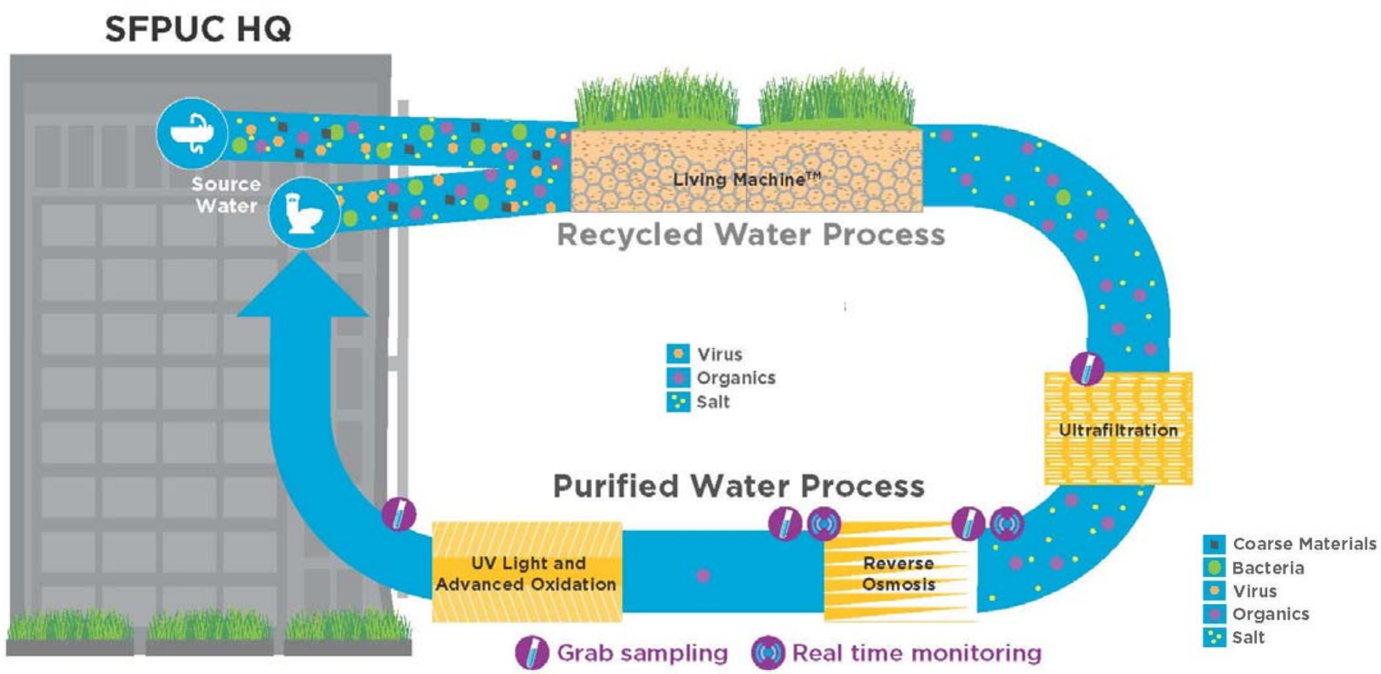
PureWaterSF



PureWaterSF

Evaluate Building-Scale Treatment

- Demonstrate at a – ***building scale*** – the capability to treat the wastewater onsite to achieve water quality that would be suitable for augmenting drinking water supplies



PureWaterSF Project Details

- Pilot system design and operation by SFPUC and Carollo
- Pilot system components:
  - UF: WesTech with Toray
  - RO: Evoqua
  - UV (AOP): Xylem
  - Online Monitoring: s::can
- Analytics
  - Southern Nevada Water Authority
  - UC Davis
  - BioVir
  - Eurofins

San Francisco Water Power Sewer

U.S. Department of the Interior Bureau of Reclamation

Agreement # R17AC00002

The Water Research Foundation www.waterrf.org

Agreement # 04691

PureWaterSF Project Details

- SMALL Equipment that Acts BIG:
  - Fully automated control systems
  - Complete with CIPs and chemical feed systems
  - Transparent piping to showcase water quality

PureWaterSF Demonstration Room - Pre-Installation

PureWaterSF Demonstration Room

UF

RO

UV

Online Monitoring – s::can micro::station

Parameters	RO Feed	RO Permeate
Chloramines	✓	
Free Chlorine	✓	✓
Total Organic Carbon (TOC)	✓	✓
Dissolved Organic Carbon (DOC)	✓	
Turbidity	✓	✓
UVA at 254 nm	✓	✓
Nitrate	✓	✓
Nitrite		✓
pH		✓
Temperature		✓

Challenges of Building-Scale Treatment

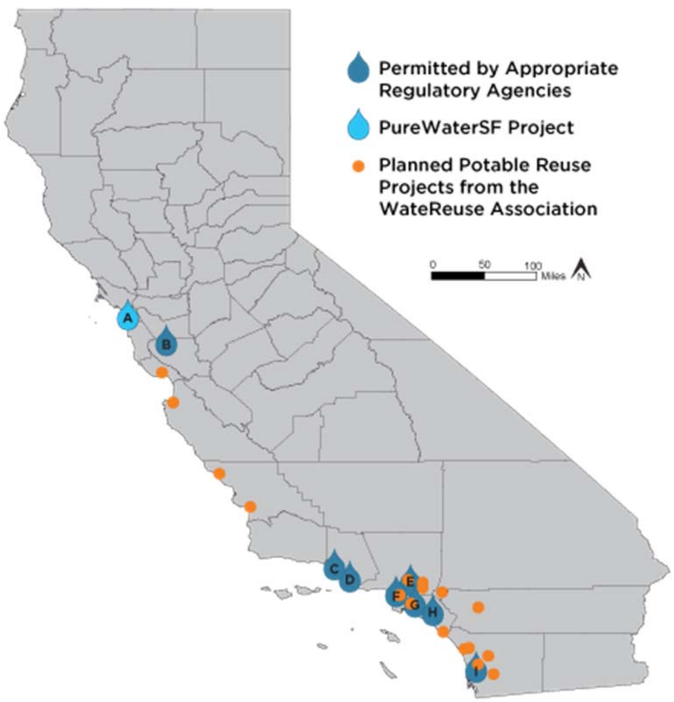
- Small footprint
  - Redundancy
  - Chemical storage
- Cost
  - Customized equipment
- Operation
  - More variability
  - Low RO recovery rate
- Safety
  - Chemical storage

Importance of Risk Assessment for PureWaterSF

Demonstrates reliability and risk of advanced water treatment systems at a building scale

- Characterizing advanced treatment performance
- Pathogen monitoring of raw wastewater
  - Different than municipal-scale wastewater
  - Variable – seasonal
- Demonstrate monitoring technologies reliability

Importance of Risk Assessment for PureWaterSF

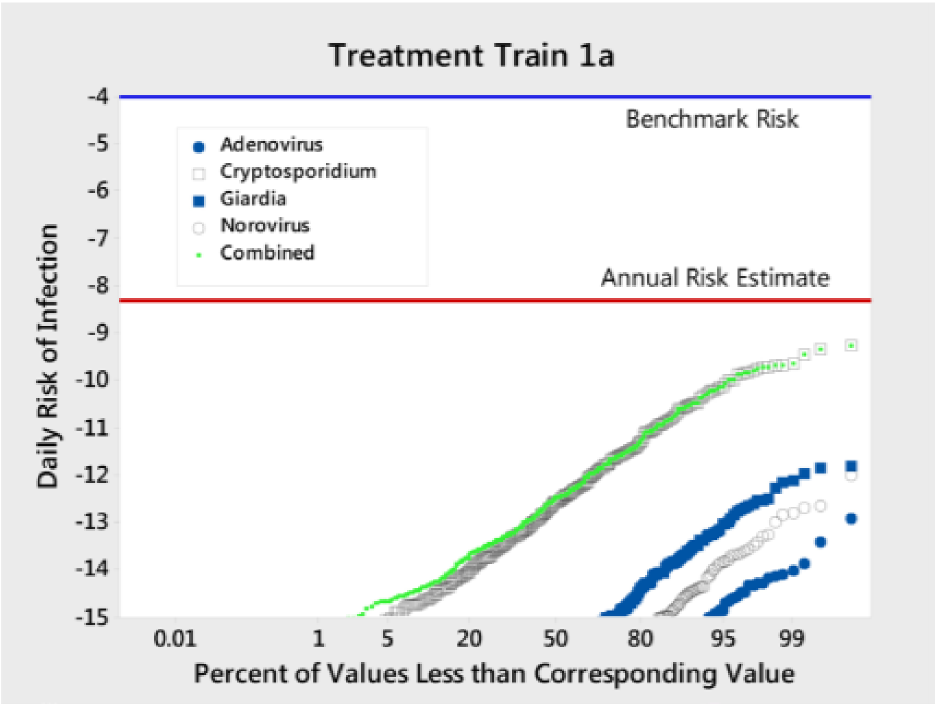


Adds to growing body of data to help fill research gaps in statewide efforts, as recommended by the Expert Panel.

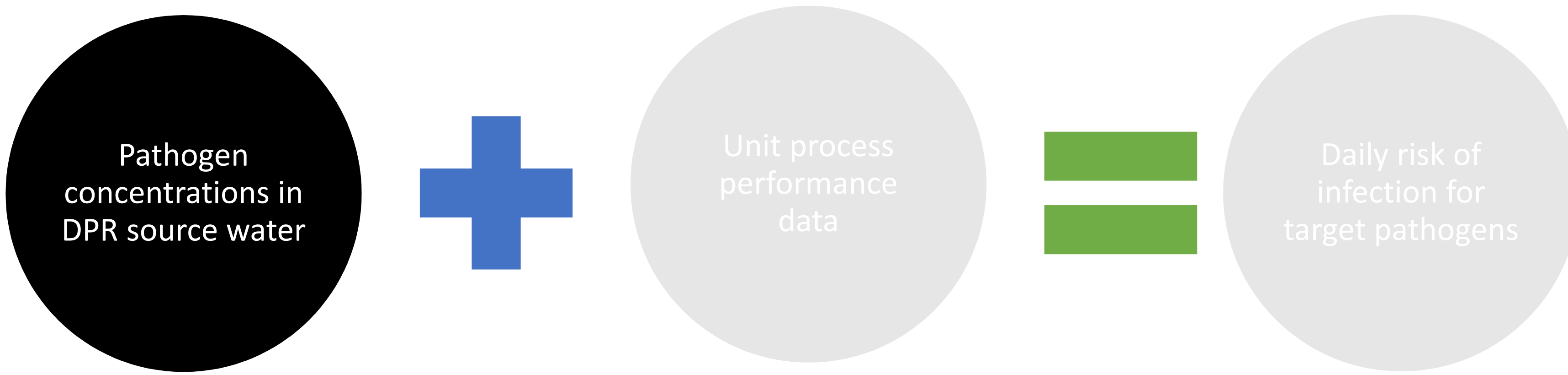
- Approach to address public health risk of these treatment systems aligns with the statewide framework for potable reuse
  - QMRA is the underlying framework for how pathogen treatment requirements are being developed for CA
  - Already existing treatments for groundwater, etc.
  - QMRA where numbers came from for DPR and where they mostly will come from.
- This understanding will inform SFPUC understanding of how QMRA standards are developed.

Quantitative Microbial Risk Assessment (QMRA)

- A tool to characterize risks associated with pathogens, and demonstrates the effectiveness of various advanced treatment technologies
    - Monte Carlo Simulation

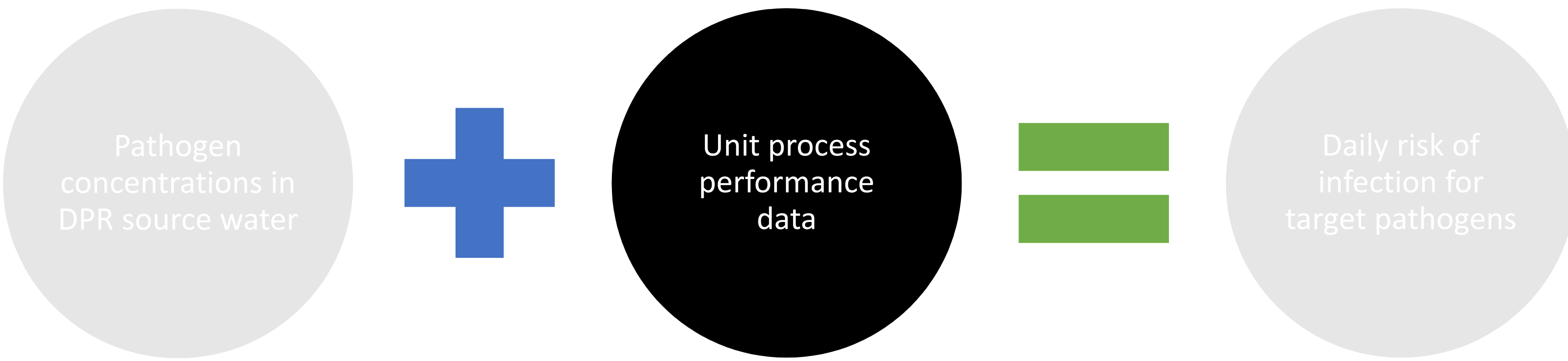


What Information Does QMRA Need?

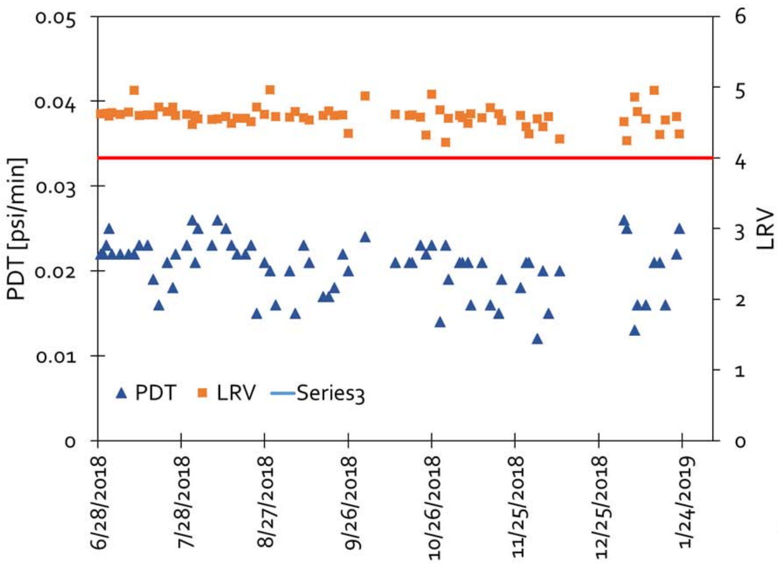


- Raw Wastewater (18 samples – bimonthly)
  - Norovirus (GIA, GIB, GII)
  - Enterovirus
  - Adenovirus
  - *Giardia*
  - *Cryptosporidium*

What Information Does QMRA Need?

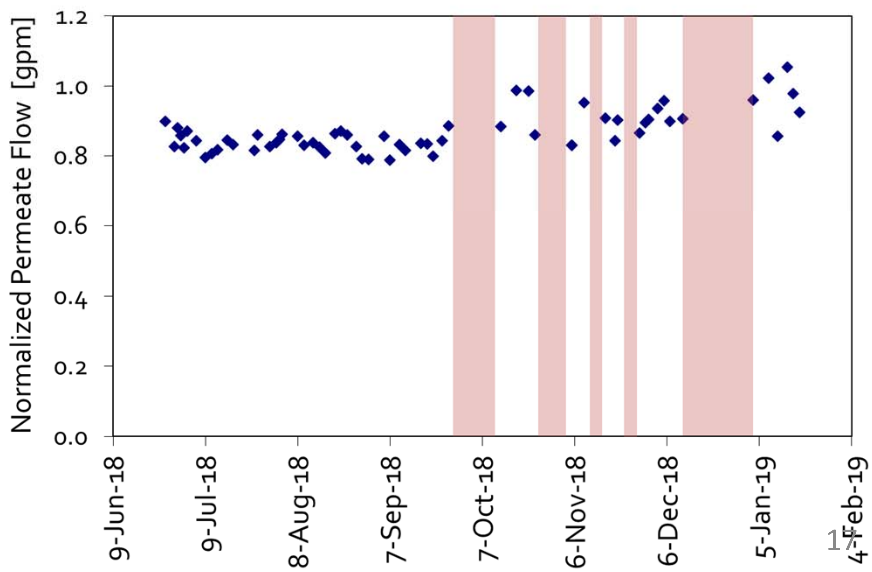


Preliminary Performance Data

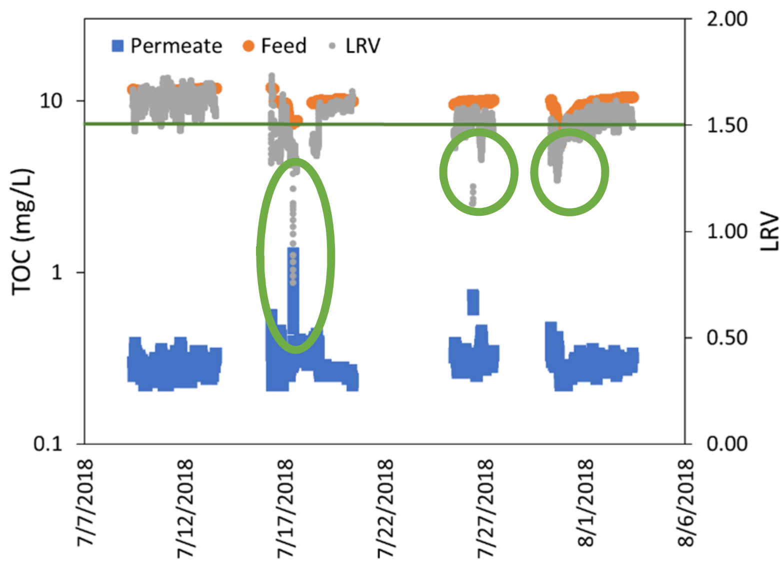


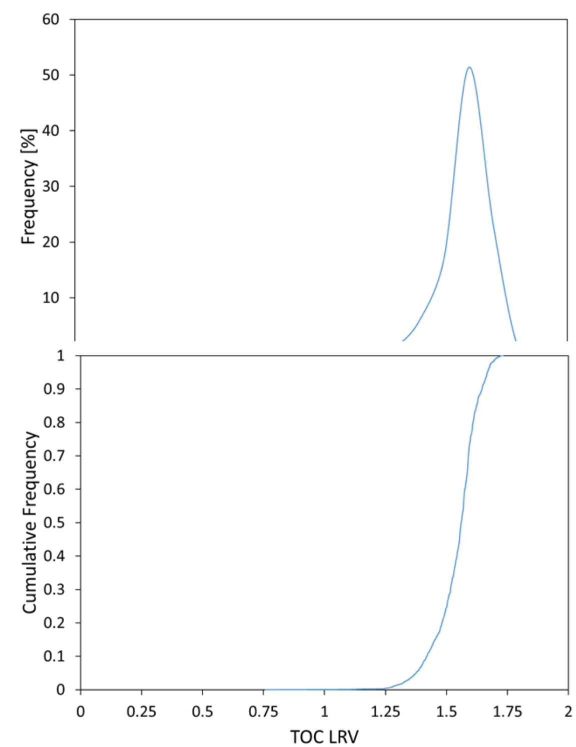
UF demonstrates 4 to 5 LRV of both Giardia and Cryptosporidium
Average LRV = 4.59
5th percentile = 4.36

Stable operation of RO over the last 9 months
Recovery rate = 47%
EC Average LRV = 1.17
5th percentile = 1.01



TOC online monitoring preliminary results





Average LRV = 1.52

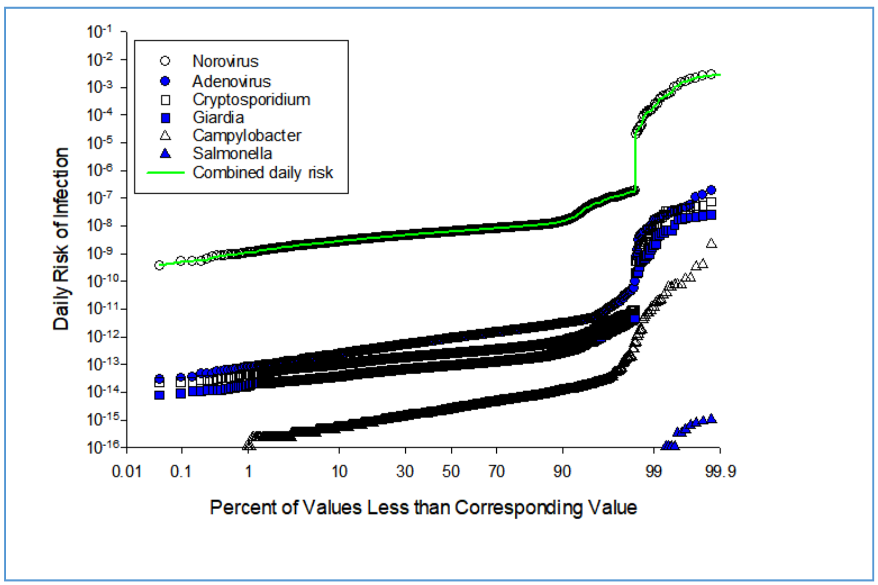
5th percentile = 1.41

What Information Does QMRA Need?

Pathogen concentrations in DPR source water

Unit process performance data

Daily risk of infection for target pathogens



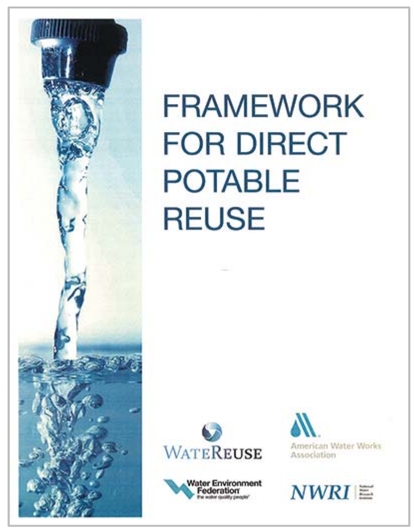
WRF 1416

Trace and unknown chemicals and Bioassays also under investigation

Bioassays

- Estrogen like chemicals
- Glucocorticoid / progesterone like chemicals
- Androgen like chemicals
- Dioxin like chemicals
- Genotoxicity
- Cytotoxicity

Trace Level Chemical Pollutants



	Criterion
Perfluoro-octanoic acid (PFOA)	0.4 ug/L
Perfluoro-octane sulfonate (PFOS)	0.2 ug/L
Perchlorate	15 ug/L 6 ug/L
1,4-Dioxane	1 ug/L
Ethinyl Estradiol	Detection limit
17-ß-estradiol	Detection limit
Cotinine/Primidone/Dilantin	1/10/2 ug/L
Meprobamate/Atenolol	200/4 ug/L
Carbamazepine	10 ug/L
Estrone	320 ng/L
Sucralose	150 mg/L
Tris(2-chloroethyl)phosphate (TCEP)	5 ug/L
N,N-diethyl-meta-toluamide (DEET)	200 ug/L
Triclosan	2,100 ug/L

* Reproduced from Trussell et al., 2013.

Summary

- UF and RO performed as expected during the operation
- Ongoing sampling
  - Raw Wastewater Pathogen
  - CECs
  - Bioassays
  - UVAOP Challenge Test
- Next Steps
  - Data Analysis and QMRA

Acknowledgments

- SFPUC staff
- Project team
- Funding partners

Agreement # R17AC00002　　Agreement # 04691

Thank you!

Manisha Kothari, Project Manager
San Francisco Public Utilities Commission
MKothari@sfwater.org

Andrea F. Corral, Lead Technologist
Carollo Engineers, Inc.
acorral@carollo.com

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

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Living Machine™ at SFPUC Headquarters

- Constructed wetland
  - 5,000 gpd
  - Meets Title 22 Recycled Water Regulations
  - 60% reduction of water use in the building
  - Reuse for toilet flushing

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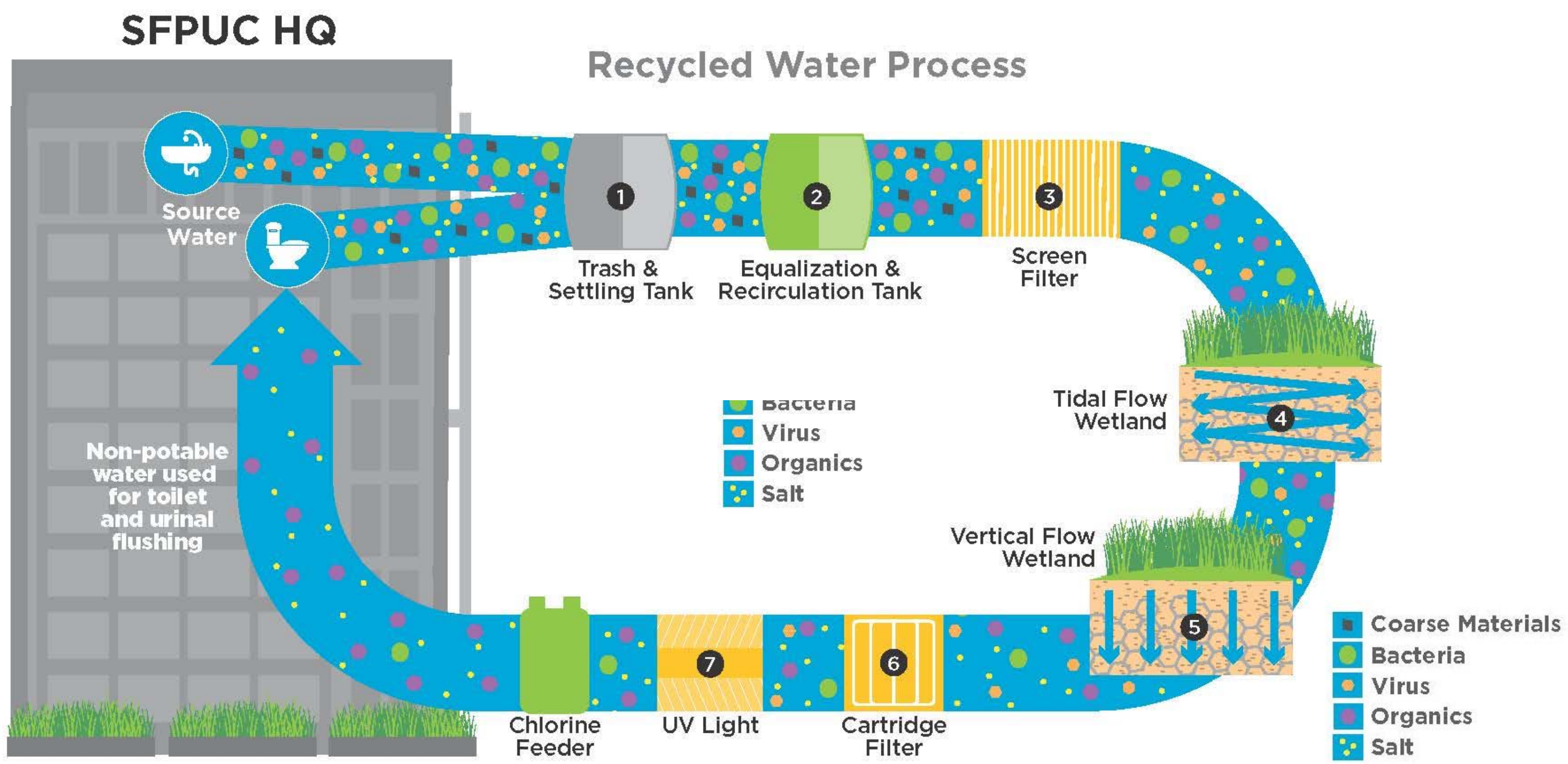
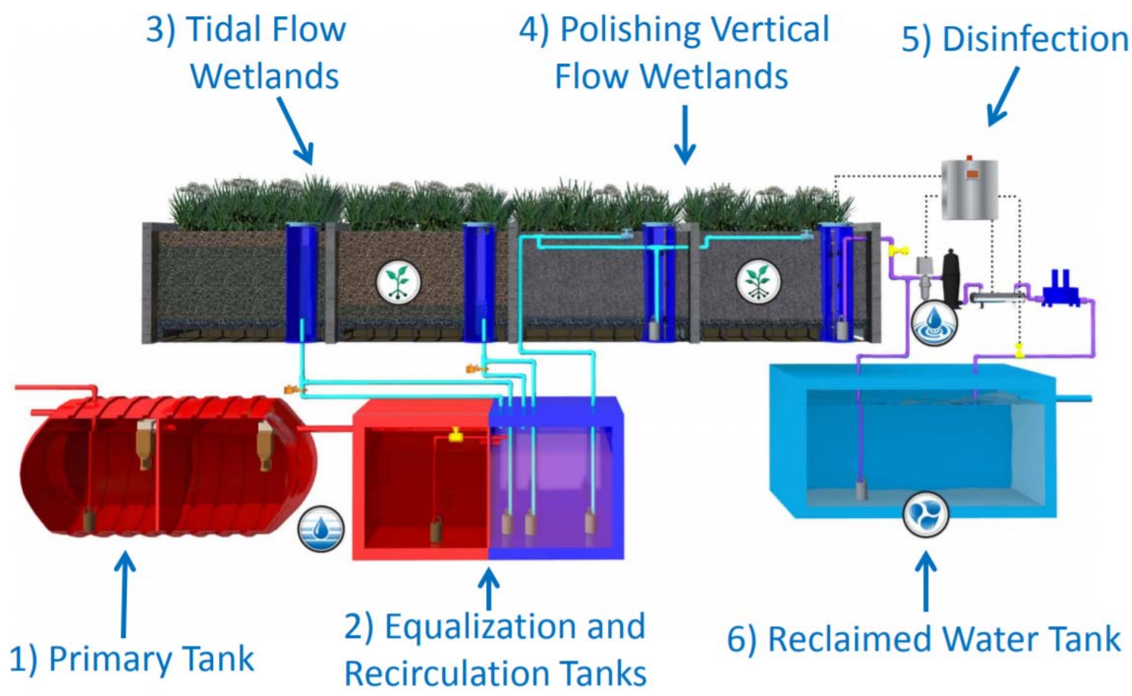
Living Machine™ Treatment Process



Living Machine Treatment Train



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Living Machine™ at SFPUC HQ

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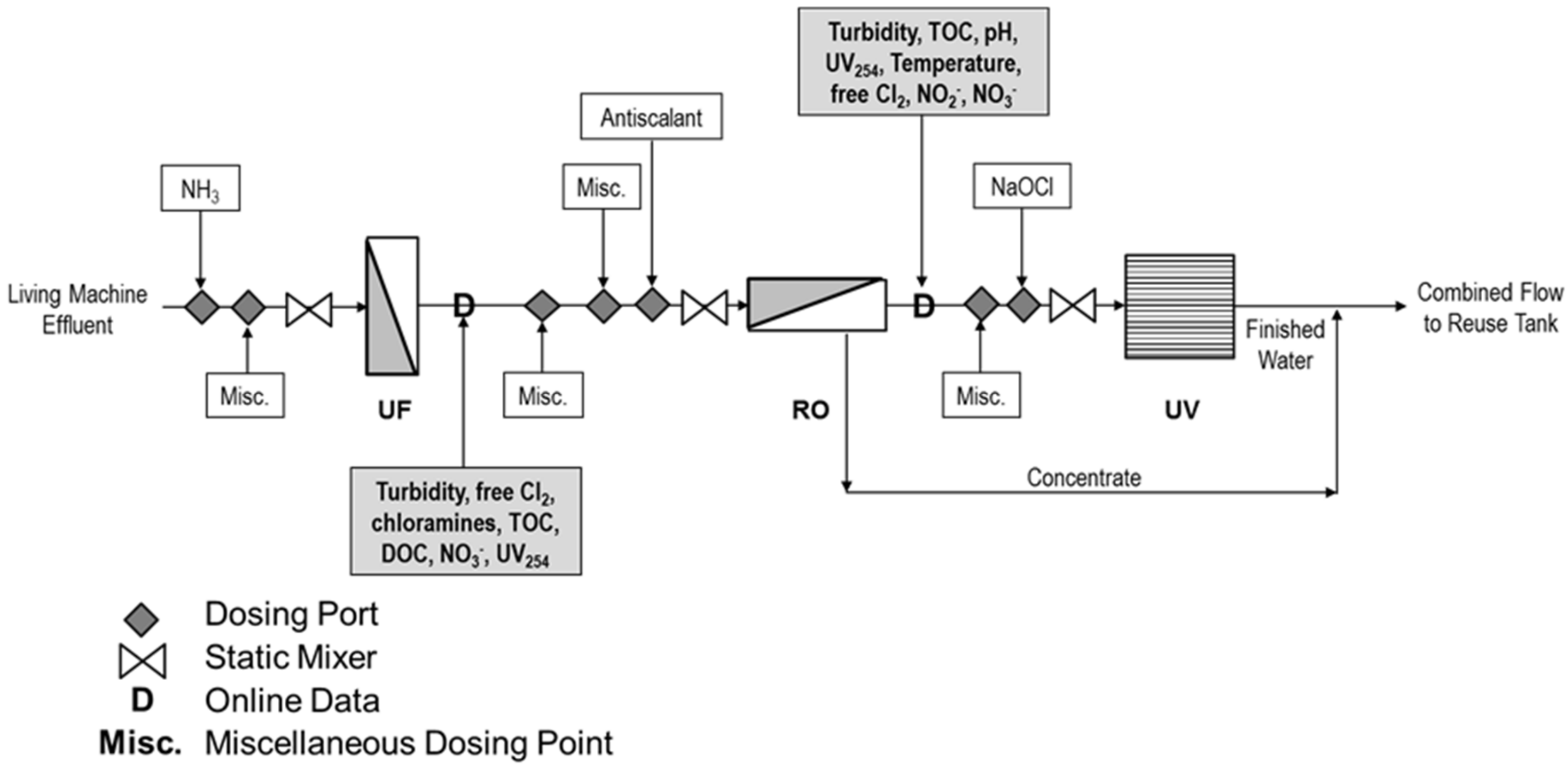
PureWaterSF Objectives

- Demonstrate at a – *building scale* – the capability to treat the wastewater onsite to achieve water quality that would be suitable for augmenting drinking water supplies
- Demonstrate monitoring technologies reliability
- Provide data to help fill in current gaps in statewide efforts
- Deliver a community-focused education and outreach program on purified water to strengthen connection between technical results and public acceptance

PureWaterSF Pilot Schematic



PureWaterSF Outreach and Education

- On Site Tours
- Video Tour
- Website
- Digital Wall
- Educational Materials