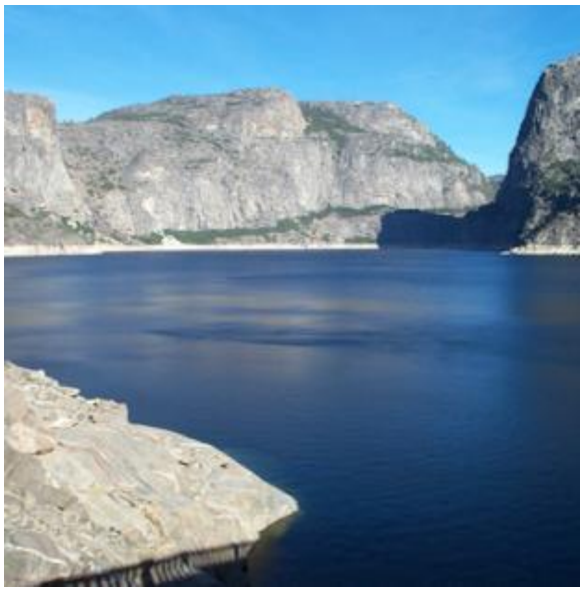
San Francisco Water Power Sewer

# Implementing an Onsite Reuse Program In San Francisco

**Taylor Chang, SFPUC**
**Sarah Triolo, Trussell Technologies**

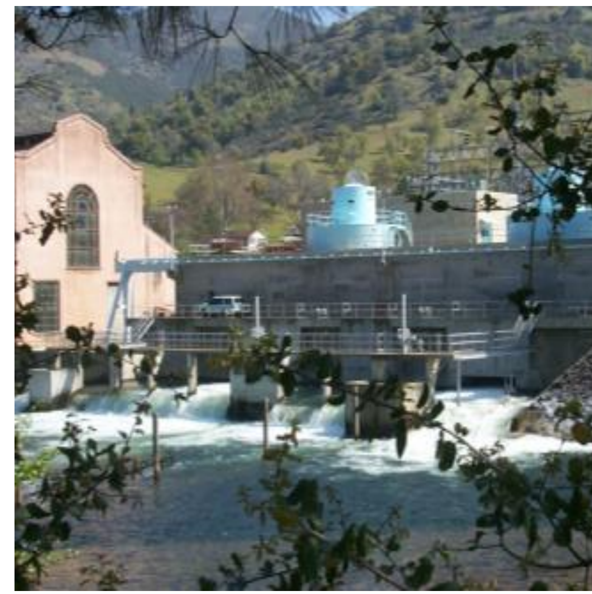
**WateReuse Northern California**
**February 23, 2018**

# San Francisco Public Utilities Commission



Water: delivering high quality water every day to 2.6 million people

Wastewater: protecting public health and the environment



Power: generating clean energy for vital City services

# San Francisco's Local Water Program

HETCH HETCHY
+ LOCAL WATER
Better together.

Conservation

Groundwater

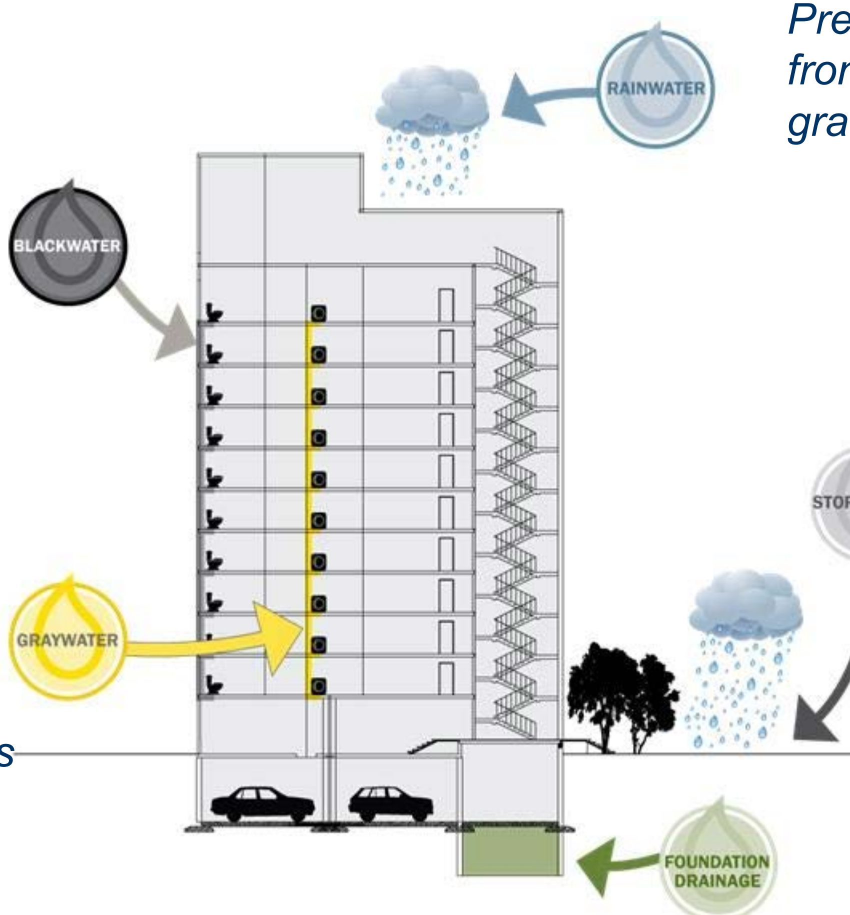
Recycled Water

Non-potable Water

# Building Alternate Water Sources

*Precipitation collected from roofs and above-grade surfaces*

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

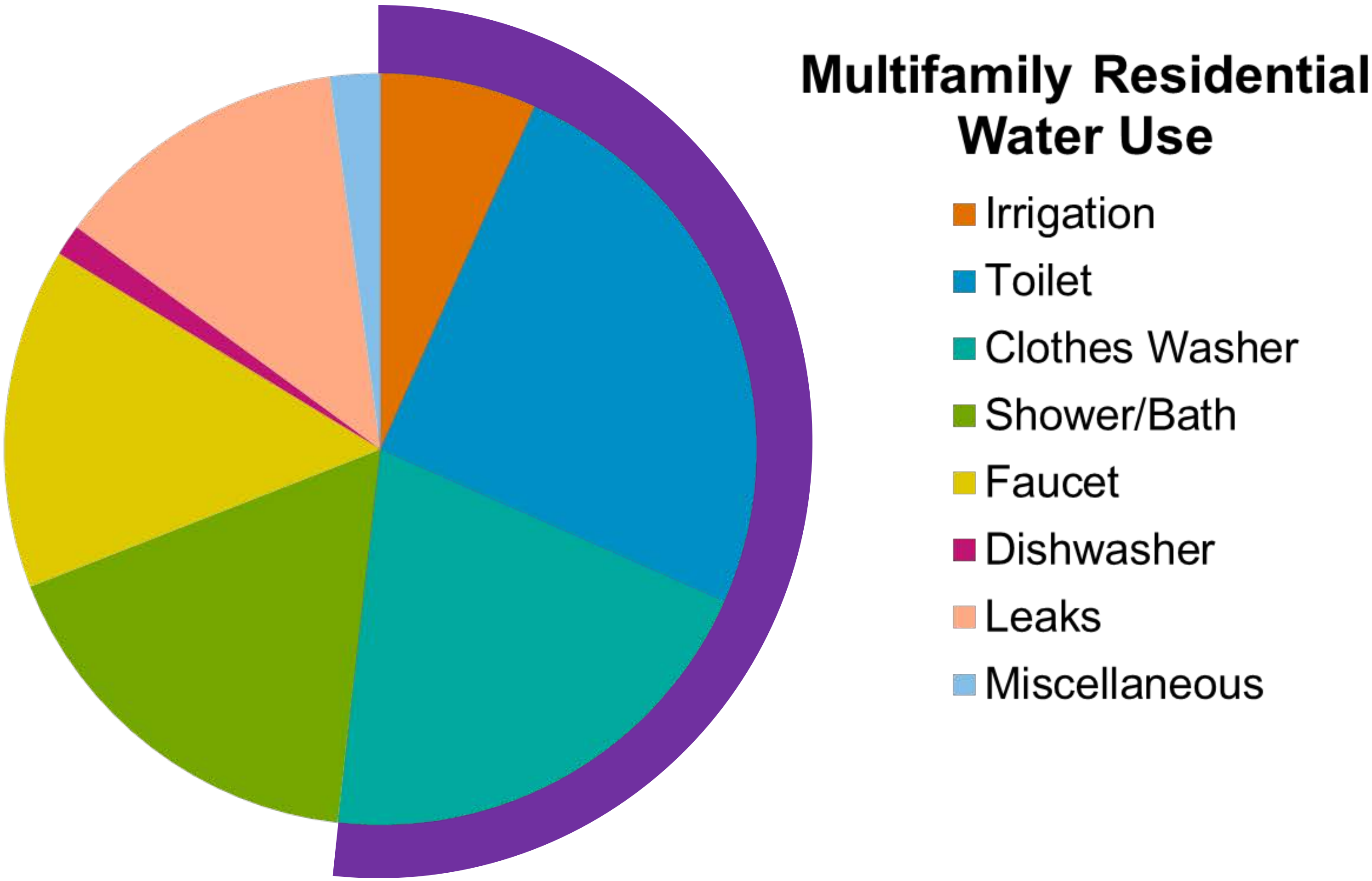



*Precipitation collected at or below grade*

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

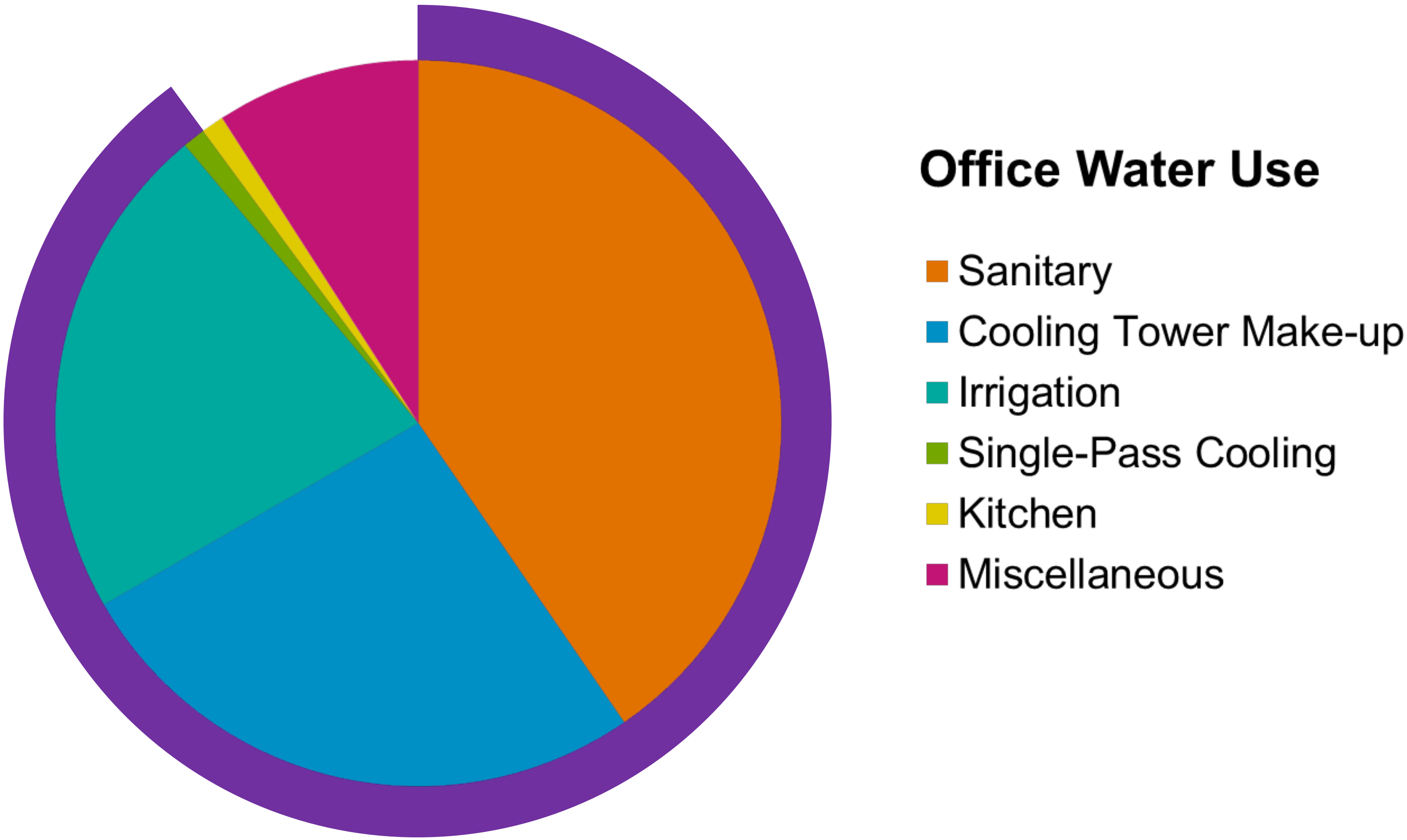
*Nuisance groundwater from dewatering operations*

# Up to 50% of Demands are Non-potable in Multi-family Residential Buildings




*Source: adapted from Alliance for Water Efficiency*

# Up to 95% of Demands are Non-potable in Commercial Buildings




*Source: USEPA*

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# Onsite Non-potable Water Use at Innovative SFPUC Headquarters

## Rainwater Harvesting System

- 25,000 gallon cistern
- Reuse for irrigation

## Wetland Treatment System

- Collects and treats building’s wastewater
- Reuse for toilet flushing
- 5,000 gpd capacity

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# Developers Interested in Collecting & Treating Water Onsite

# Existing Water Quality Criteria

| Alternate Water Source | Regulation |
|---|---|
| Blackwater | Title 22 |
| Graywater | California Plumbing Code - NSF-350 |
| Rainwater | California Plumbing Code |
| Stormwater<br><br>Foundation Drainage | No state codes -<br>SFDPH established |

- CA Plumbing Code includes purple pipe, signage & construction requirements, but **no oversight and management**

# Developing a Program to Allow Onsite Water Systems

- 2010 Research and develop program concept and with Water and Wastewater staff
- 2011 Discussion with SFDBI and SFDPH
- 2012 Extensive stakeholder outreach
- 2012 Prepare Ordinance for SF

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# Ordinance Amends SF Health Code October 2012

- Article 12C: establishes a regulatory structure that provides administrative and project approval process
- Roles and responsibilities for City Departments
- Sets application fees & annual fees for SFDPH
- Provides ability to impose penalties by SFDPH (Chapter 100 of Admin Code)

# Overview of Roles and Responsibilities

| SFPUC | SFDPH | SFDBI | SFPW |
|---|---|---|---|
| Program Administration and Cross-Connection Control | Public Health | Construction | Right of Way and Mapping |
| Review onsite non-potable water supplies & demands<br><br>Administer citywide project tracking & annual potable offset achieved<br><br>Provide technical support & outreach to developers<br><br>Manages Cross-Connection Control Program | Issue water quality & monitoring requirements<br><br>Review and approve non-potable engineering report<br><br>Issue permit to operate onsite systems<br><br>Review water quality reporting | Conduct Plumbing Plan check and issue Plumbing Permit<br><br>Inspect and approve system installations | Issue Encroachment Permits as needed for infrastructure in the Right-of-Way (if needed)<br><br>Includes condition on a subdivision map or a parcel map requiring compliance with the Non-potable Ordinance prior to approval and issuance of said map (if applicable) |

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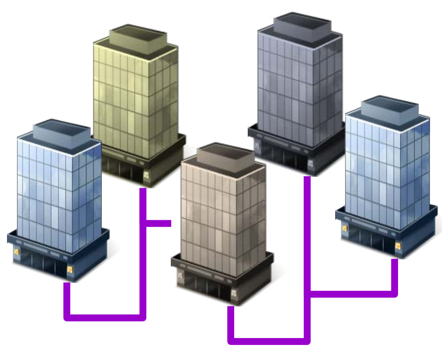
# An Evolving Non-potable Water Program

**2012**
Single Building

**2013**
District-scale



**2015**
Mandatory for projects
≥ 250,000 sf

**2016**
Implementation
Requirements for
District-scale Systems

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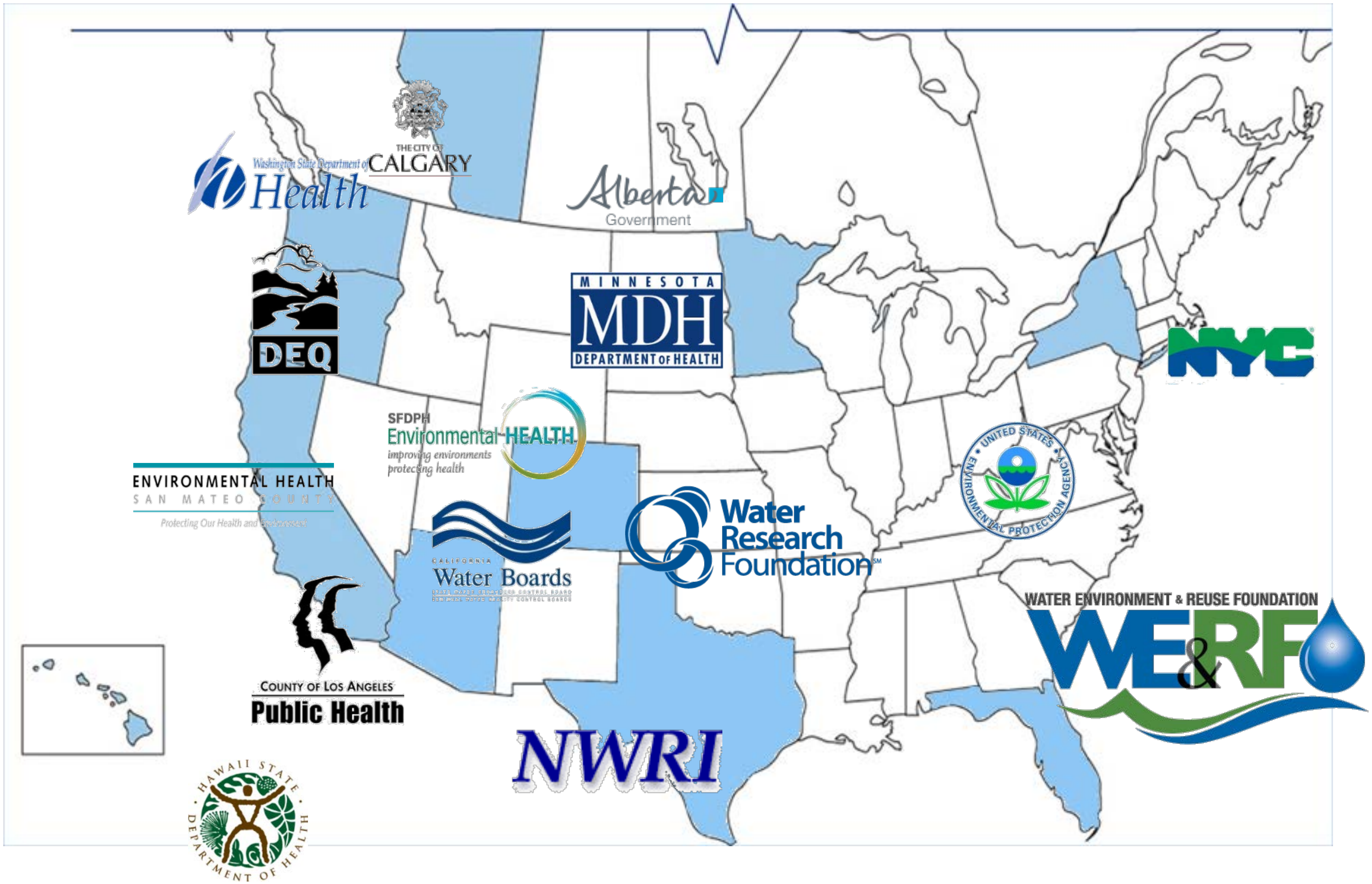
# Expanding Partnership to Develop Risk-Based Public Health Guidance



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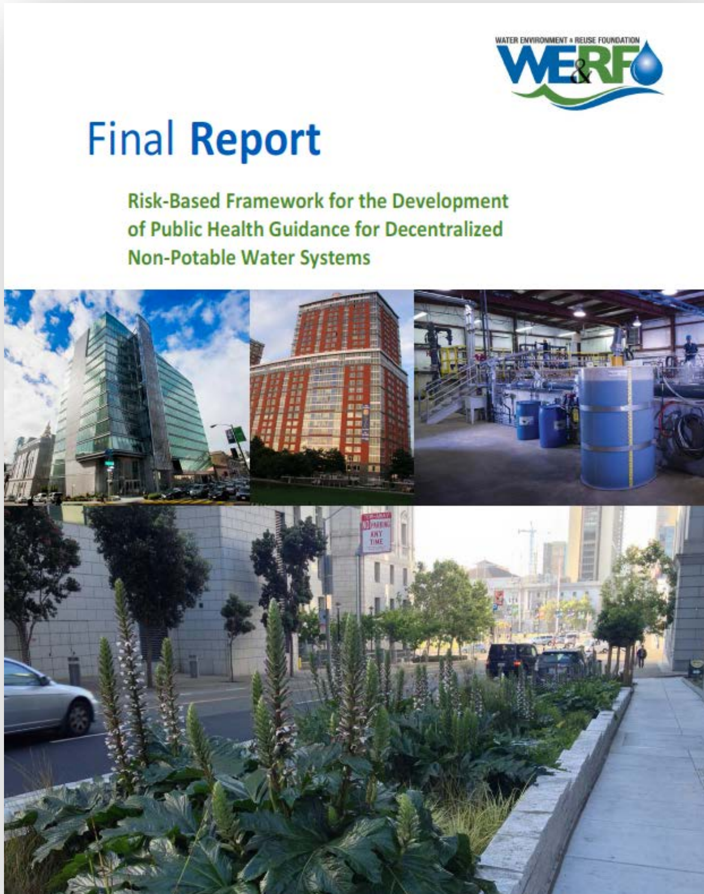
# *Risk-Based Framework for the Development of Public Health Guidance for DNWS*




- Published March 2017
- Prepared by a 6 member Independent Advisory Panel, managed by National Water Research Institute
- Sponsored by WE&RF, WRF, and SFPUC

## *Risk-Based Framework for the Development of Public Health Guidance for DNWS*

- Research established **risk-based water quality standards** and recommendations for **management and permitting** of onsite non-potable water systems
- Water quality criteria based on Log Reduction Targets (LRT) for removal of virus, protozoa, and bacteria
- Treatment system performance standards
- Continuous online monitoring requirements

# Log Reduction Targets (LRTs)

- NWRI report considers pathogens to be the greatest concern to human health in onsite non-potable water systems
- Risk-based pathogen **LRTs** were established using a methodology that estimates the potential health risk associated with exposure to **viruses, protozoa, and bacteria**
- Methodology is based on widely accepted practices for potable reuse and drinking water

# LRT Table

| Log Reduction Targets for Blackwater, Graywater, and Roof Runoff | | | |
|---|---|---|---|
| **Alternate Water Use Scenario** | **Enteric Viruses** | **Parasitic Protozoa** | **Enteric Bacteria** |
| Domestic Wastewater or Blackwater | | | |
| Unrestricted Irrigation | 8.0 | 7.0 | 6.0 |
| Indoor Use | 8.5 | 7.0 | 6.0 |
| Graywater | | | |
| Unrestricted Irrigation | 5.5 | 4.5 | 3.5 |
| Indoor Use | 6.0 | 4.5 | 3.5 |
| Roof Runoff | | | |
| Unrestricted Irrigation | Not applicable[1] | No data[1] | 3.5 |
| Indoor Use | Not applicable[1] | No data[1] | 3.5 |

# LRT Table

| Log Reduction Targets for Stormwater | | | |
|---|---|---|---|
| **Alternate Water Use Scenario** | **Enteric Viruses** | **Parasitic Protozoa** | **Enteric Bacteria** |
| Stormwater ($10^{-1}$ dilution) | | | |
| Unrestricted Irrigation | 5.0 | 4.5 | 4.0 |
| Indoor Use | 5.5 | 5.5 | 4.0 |
| Stormwater ($10^{-3}$ dilution) | | | |
| Unrestricted Irrigation | 3.0 | 2.5 | 2.0 |
| Indoor Use | 3.5 | 3.5 | 3.0 |

# Risk-Based Framework

In addition to developing the risk-based treatment performance standards, the research highlighted:

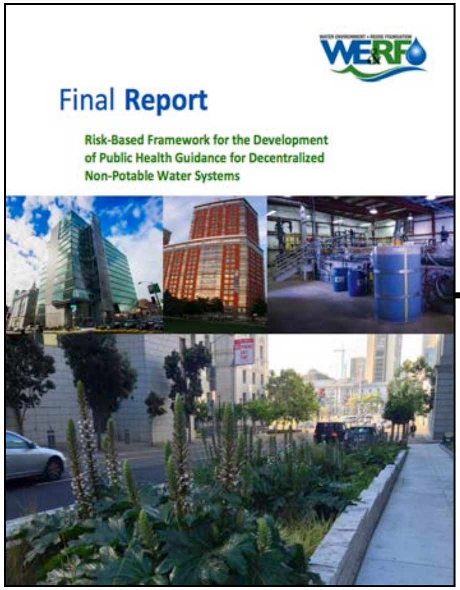
- Need for guidance on establishing oversight and management programs for onsite non-potable water systems
- Consistent approach to permitting from state-to-state

# SF Non-potable Program Updates

- Drawing on the NWRI research, SFDPH updated its Rules and Regulations for onsite non-potable water systems in August 2017

- SFDPH Revised Rules and Regulations incorporate:
  - **Water quality criteria based on Log Reduction Targets (LRT)**
  - **Treatment system performance standards**
  - **Continuous online monitoring requirements**

# Implementing the Risk-Based Treatment Standards

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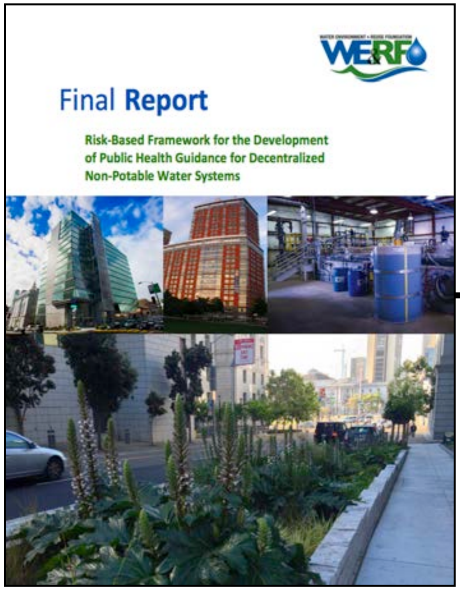
# Implementing the Risk-Based Treatment Standards




Treatment

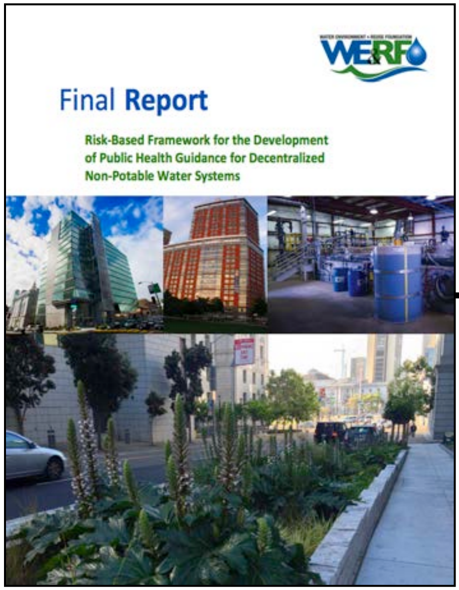
+

Monitoring

+


Permitting

# Implementing the Risk-Based Treatment Standards



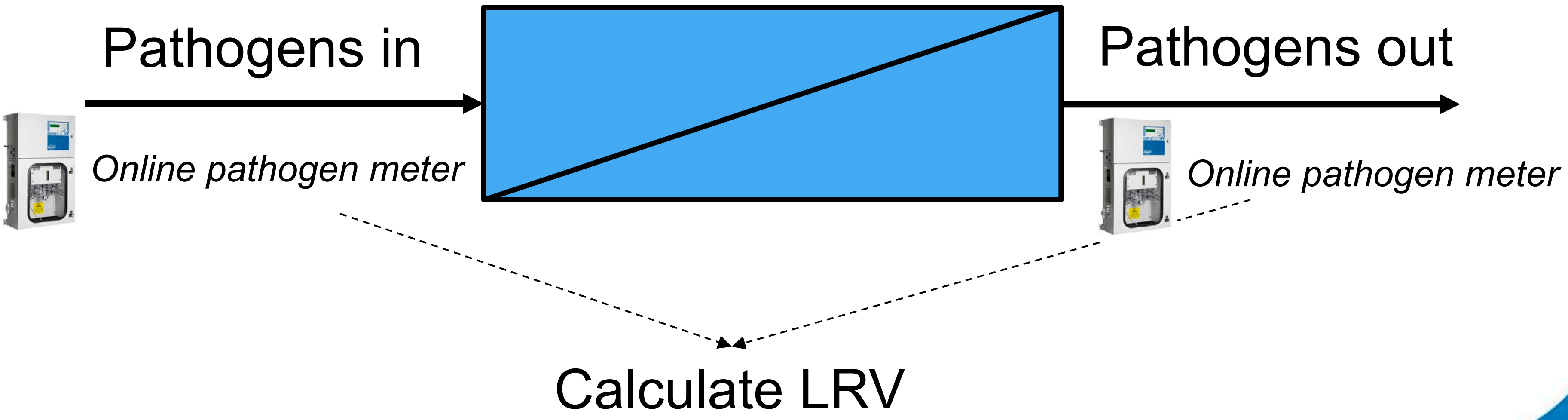

Treatment

Monitoring

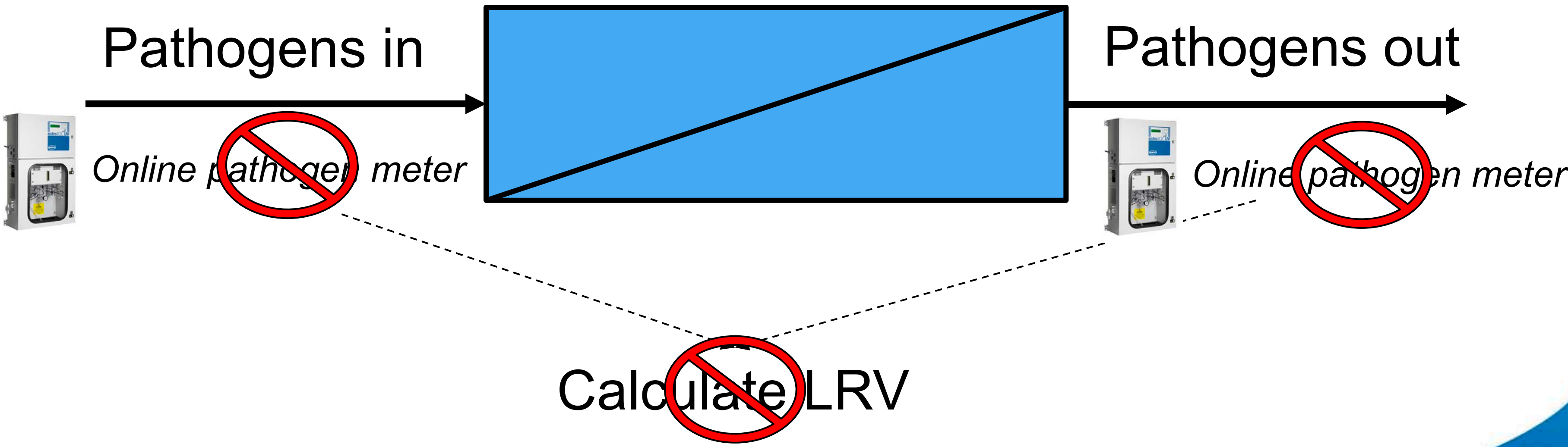

Permitting

- What kind of treatment and monitoring are needed?
- How do we evaluate whether systems are meeting LRTs?

# Pathogen Crediting:
# *Ideal Approach*

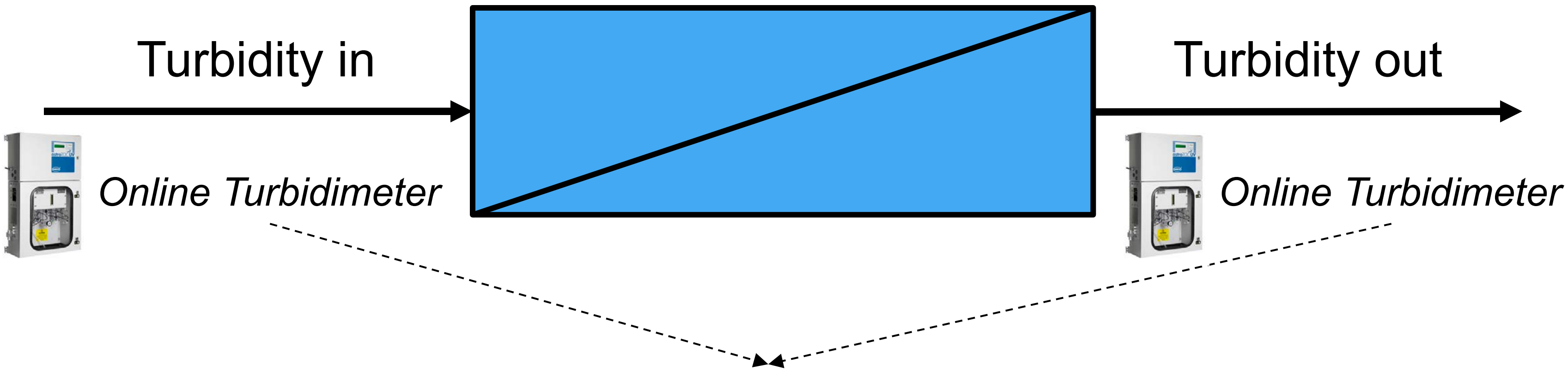


# Pathogen Crediting: *Ideal Approach*




- **Can’t be done in real-time**
- **Concentrations often too low to measure**

# Pathogen Crediting: *Surrogate Approach*




**Determine LRV in real time**
**Continuously demonstrate process performance**

# Pathogen Crediting: *Surrogate Approach*

**Ideal surrogates:**
- High analytical sensitivity
- Conservative indication of pathogen reduction
- Continuous monitoring available

# Pathogen Crediting:
# *Surrogate Approach*

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United States Environmental Protection Agency | Office of Water (4601) | EPA 815-R-06-009 November 2005

EPA

**MEMBRANE FILTRATION GUIDANCE MANUAL**

$$LRV = \log\left(\frac{Q_p \times ALCR \times P_{atm}}{\Delta P_{test} \times V_{sys} \times VCF}\right)$$

Eqn. 4.9 of EPA (2005)

where,

$LRV$ = log reduction value
$Q_P$ = membrane unit design capacity filtrate flow (gpm)
$ALCR$ = air liquid conversion ratio
$P_{atm}$ = atmospheric pressure (psia)
$\Delta P_{test}$ = measured test decay rate (psi/min)
$V_{sys}$ = volume of pressurized air in the system during the test (gal)
$VCF$ = volumetric concentration factor (dimensionless)

# Existing Crediting Frameworks

## FILTRATION

*Cartridge Filtration*

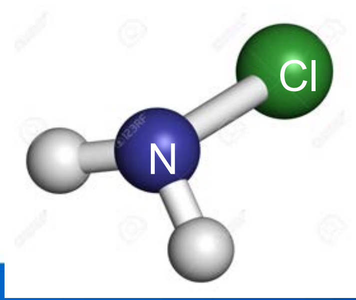
*Membrane Filtration*

*Reverse Osmosis*

## DISINFECTION

*Ultraviolet Light*

*Free Chlorine*




*Chloramine*

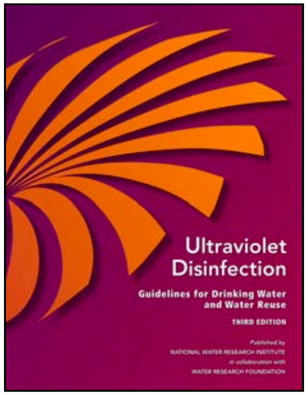
United States Environmental Protection Agency | Office of Water (4601) | EPA 815-R-06-009 November 2005

EPA

**MEMBRANE FILTRATION GUIDANCE MANUAL**

EPA United States Environmental Protection Agency

**LONG TERM 2 ENHANCED SURFACE WATER TREATMENT RULE TOOLBOX GUIDANCE MANUAL**




GUIDANCE MANUAL
FOR
COMPLIANCE WITH THE
FILTRATION AND DISINFECTION REQUIREMENTS
FOR
PUBLIC WATER SYSTEMS
USING
SURFACE WATER SOURCES

MARCH 1991 EDITION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

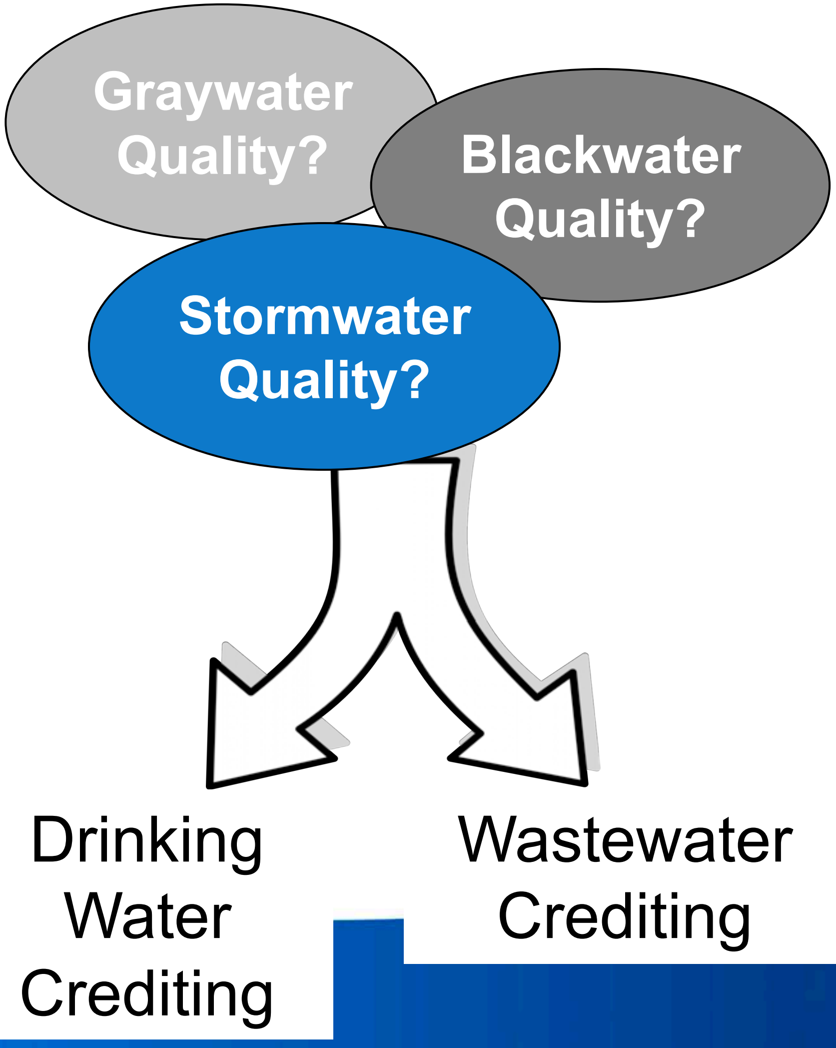
SCIENCE AND TECHNOLOGY BRANCH
CRITERIA AND STANDARDS DIVISION
OFFICE OF DRINKING WATER
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

United States Environmental Protection Agency | Office of Water (4607) | EPA 815-R-99-013 August 1999

EPA

**Disinfection Profiling and Benchmarking Guidance Manual**

# Applying Existing Frameworks to DNWS




# DNWS Potential Water Quality

| | Blackwater | Graywater [a] |
|---|---|---|
| Turbidity | -- | 11 - 858 |
| Total suspended solids (TSS) | 920 – 4,320 [b] | 5 - 705 |
| Total organic carbon (TOC) | 80 – 260 [c] | 25 - 503 |
| Biological oxygen demand (BOD) | 410 – 1,400 [b] | 16 - 636 |

[a] As reported in WRF 4665 (in press)

[b] Palmquist and Hanaeus (2005), Gallagher and Sharvelle (2011)

[c] Expected range for municipal wastewater

***High solids & organics***

# DNWS Potential Water Quality

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|---|---|---|
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[b] Palmquist and Hanaeus (2005), Gallagher and Sharvelle (2011)
[c] Expected range for municipal wastewater

**Likely to need some combination of:**

**Biological Stabilization**

**Filtration**

**Disinfection**

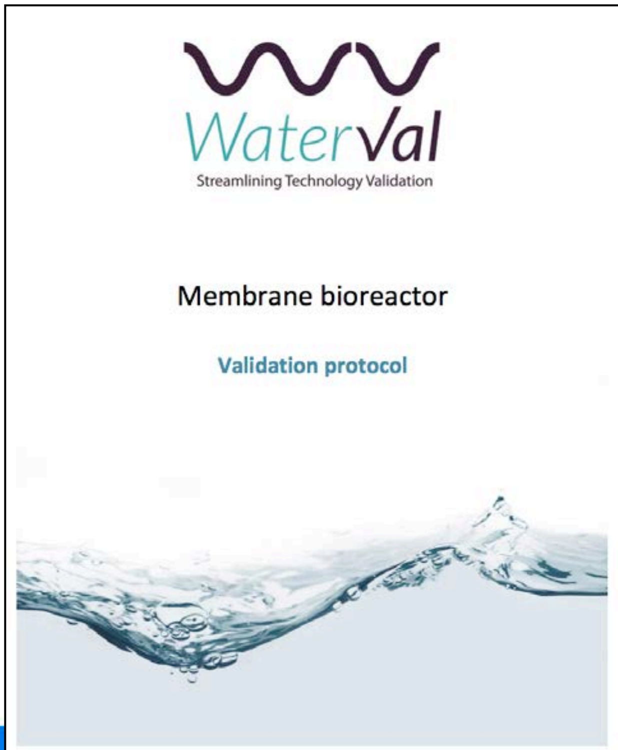
# Applying Existing Frameworks to DNWS: *Membrane Bioreactor*

- Combination of biological treatment system and membrane filtration system
- Effective at reducing organics (e.g. BOD, TOC) and removing solids

**Biological Stabilization**

**Filtration**

# Applying Existing Frameworks to DNWS: *Membrane Bioreactor*




***Australian Validation Protocol***

## ***Operating Envelope***

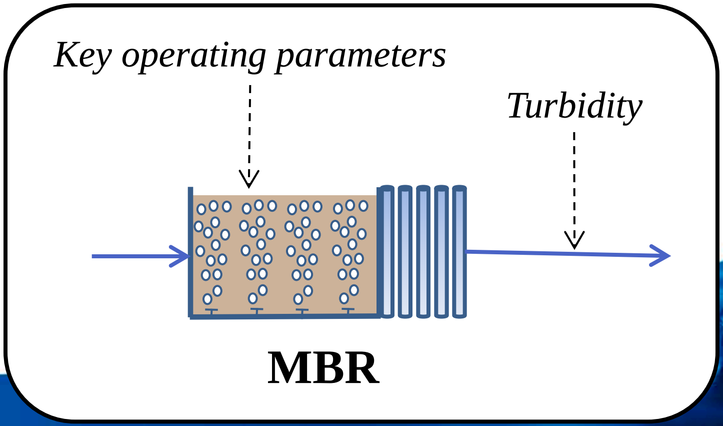
| Parameter | Units | Minimum | Maximum |
|---|---|---|---|
| Bioreactor pH | pH units | 6 | 8 |
| Bioreactor dissolved oxygen | mg/L | 1 | 7 |
| Bioreactor temperature | C | 16 | 30 |
| Solids retention time | d | 11 | -- |
| Hydraulic retention time | h | 6 | -- |
| Mixed liquor suspended solids | g/L | 3 | -- |
| Transmembrane pressure | kPa | 3 | -- |
| Flux | $L/m^2/h$ | -- | 30 |
| Turbidity | NTU | -- | 0.2 |

# Applying Existing Frameworks to DNWS: *Membrane Bioreactor*

**How to get credit for MBR treatment:**

- Select a treatment unit that can operate within envelope
- Provide continuous online monitoring of key parameters with appropriate alarms and diversions

**V / P / B**
**1.5 / 2 / 4**



# Applying Existing Frameworks to DNWS: *UV Disinfection*

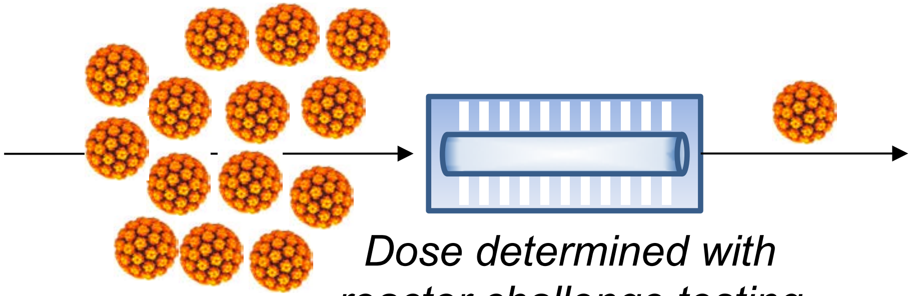
- Effective for inactivation of all pathogen types

- **Water quality is key** for treatment performance

**Disinfection**

# Applying Existing Frameworks to DNWS: *UV Disinfection*

- Surrogate for pathogen credit is **UV dose**



*Dose determined with reactor challenge testing*

- EPA UV Disinfection Guidance Manual
- German DVGW Standard
- NSF/ANSI Standard 55
- NWRI UV Disinfection Guidelines

- Validation defines operating envelope—flow rate and water quality

# Applying Existing Frameworks to DNWS: *UV Disinfection*

VIQUA
simply safe water

**PRO Series**

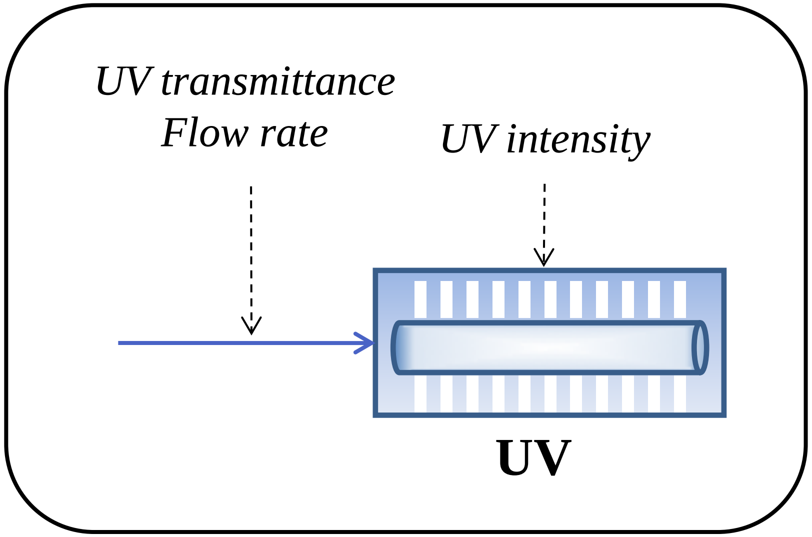

PRO10 PRO20 PRO30

| Project Name | Guidelines |
|---|---|
| Maximum flow rate | 10, 20, or 30 GPM |
| Design dose | 40, 80, or 120 mJ/cm$^2$ |
| Operating pressure | 15 psi (103 kPa) - 125 psi (862 kPa) |
| Ambient air temp. | 0°C (32°F) - 40°C (104°F) |
| Ambient water temp. | 2°C (35.6°F) - 40°C (104°F) |
| Hardness | 120 ppm (7 grains / gallon) max.* |
| Manganese content | 0.05 ppm max.* |
| Iron content | 0.3 ppm max.* |
| UVT | 75% min.* |

*after pretreatment

# Applying Existing Frameworks to DNWS: *UV Disinfection*

**How to get credit for UV disinfection:**




For UV dose of 80 mJ/cm$^2$:
**V / P / B**
**3.5 / 6 / 3.5**

For UV dose of 150 mJ/cm$^2$:
**V / P / B**
**6 / 6 / 6**

# Applying Existing Frameworks to DNWS: *Other Unit Processes*

- Membrane filtration
- Reverse osmosis
- Chlorine disinfection
- Ozone disinfection
- And others…

United States Environmental Protection Agency | Office of Water (4601) | EPA 815-R-06-009 November 2005

EPA

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**Disinfection Profiling and Benchmarking Guidance Manual**

**Non-potable Water Program Guidebook**

A Guide for Implementing Onsite Non-potable Water Systems in San Francisco

City and County of San Francisco
DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL HEALTH

Edwin M. Lee, Mayor
Barbara A. Garcia, MPA, Director of Health
Stephanie K.J. Cushing, MSPH, CHMM, REHS
Environmental Health Director

**San Francisco Department of Public Health**

**Director's Rules and Regulations Regarding the Operation of Alternate Water Source Systems**

# Additional Considerations for DNWS: *Microbial Stability & Aesthetic Quality*

- Organics in DNWS effluent can accelerate disinfectant residual decay and allow for microbial regrowth

*Color & odor in toilets*

*Legionella growth*

# Additional Considerations for DNWS: *Microbial Stability & Aesthetic Quality*

**Strategies to ensure distribution system stability:**

| Parameter | Water Quality Limit |
|---|---|
| $BOD_5$ | • The maximum concentration shall not exceed 25 mg/L at any time; and<br>• The average concentration shall not exceed 10 mg/L utilizing the results of the last 4 weeks for which analyses have been completed (Start-Up). |
| TSS | • The maximum concentration shall not exceed 30 mg/L at any time; and<br>• The average concentration shall not exceed 10 mg/L utilizing the results of the last 4 weeks for which analyses have been completed (Start-Up). |

- Monitor chlorine residual in terminal locations in the building (e.g. top floor toilets)

# Lessons Learned for DNWS: *System Design & Operations*

- Account for intermittent flows

- Biological treatment likely the most cost-effective strategy for graywater and blackwater

- Treatment is not the only aspect of public health protection
  - Water and sewer connections
  - Backflow protection
  - Cross connection testing
  - Operator capacity

# Lessons Learned for DNWS: *Engineering Reports & Permitting*

- Get feedback early

- Design criteria are important for all processes, not just those receiving pathogen credit
  - Prescreening, stabilization, etc.

- Interagency collaboration is key

# Conclusions

- Implementation of risk-based treatment standards can be simplified using existing crediting frameworks
- Water quality guides treatment selection and crediting
- Other issues are also critical for system success
  - Microbial stability
  - Cross-connection prevention
  - Operational capacity
- SFPUC’s program is already a successful example of DNWS & will continue to improve as we learn more

# THANK YOU

Taylor Chang, SFPUC
Sarah Triolo, Trussell Technologies

# QUESTIONS?