Applicability of a Risk Based Framework for Permitting Decentralized Non-Potable Water Systems in New England

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Leading the country in onsite water treatment and reuse solutions

Presented to NEWEA Annual Conference & Exhibit, Boston Massachusetts

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Outline

- Why Do We Need to Reuse Water?
- Onsite Reuse in New England
- WERF's Risk-Based Framework
- Example Application of Framework
- Questions & Answers

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Key Takeaways

1. **Risk-based Framework for DNWR is a wholistic approach to DNWR Management**
2. **Implementation of a Risk-based Framework increases public health protection**
3. **Risk-based Framework can be readily incorporated into existing or new regulatory programs**

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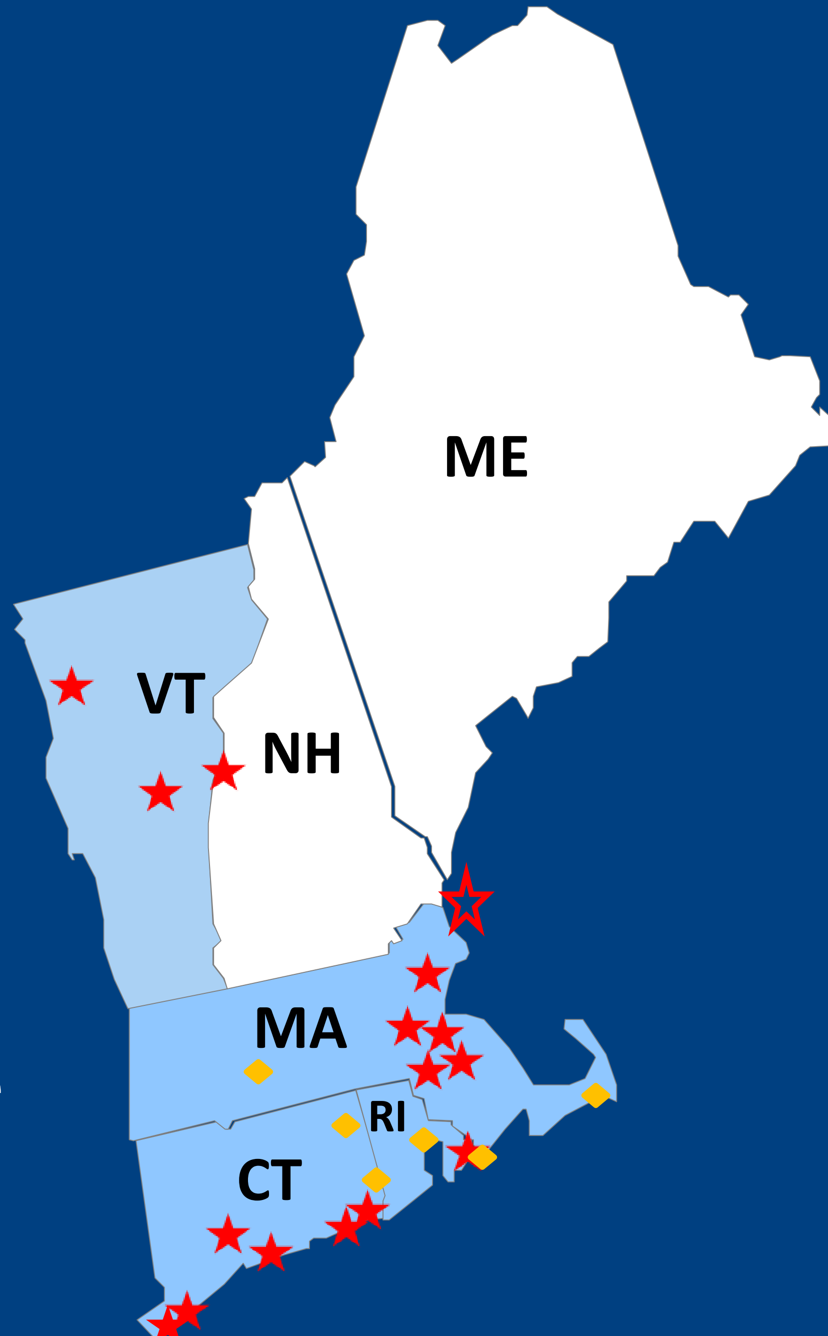
Locations of Representative Decentralized and Municipal Non-Potable Reuse in New England



Legend:
- ◆ Municipal Reuse
- ★ Decentralized Reuse
- ☆ Reuse Pilot

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Making a Difference & Tackling Our Water Challenges Together

Imbalance of Water Supply & Demand

Sustainability, Resiliency & Resource Recovery

Aging &/or Inadequate Infrastructure

Rising Costs

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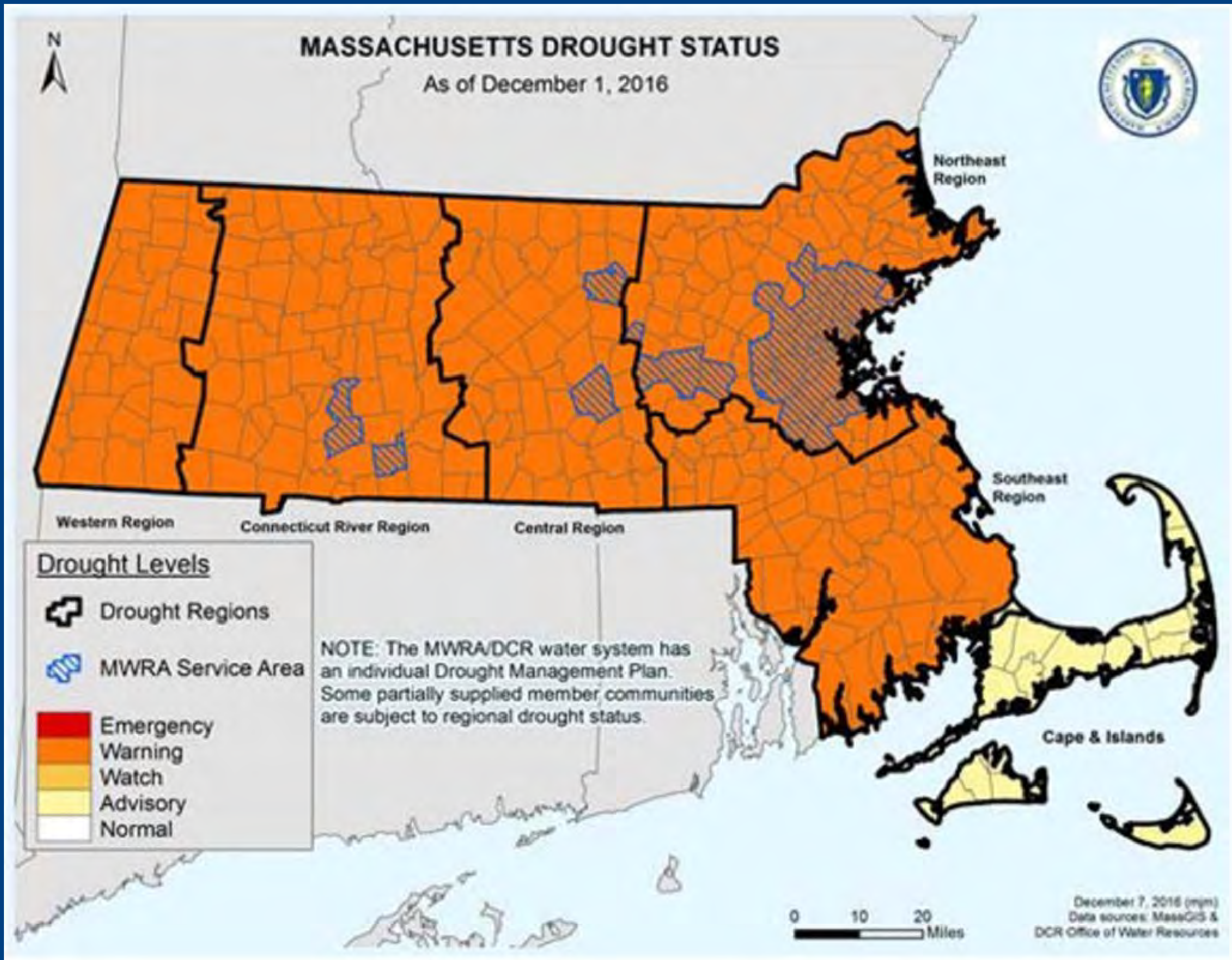
Drought Conditions in Massachusetts



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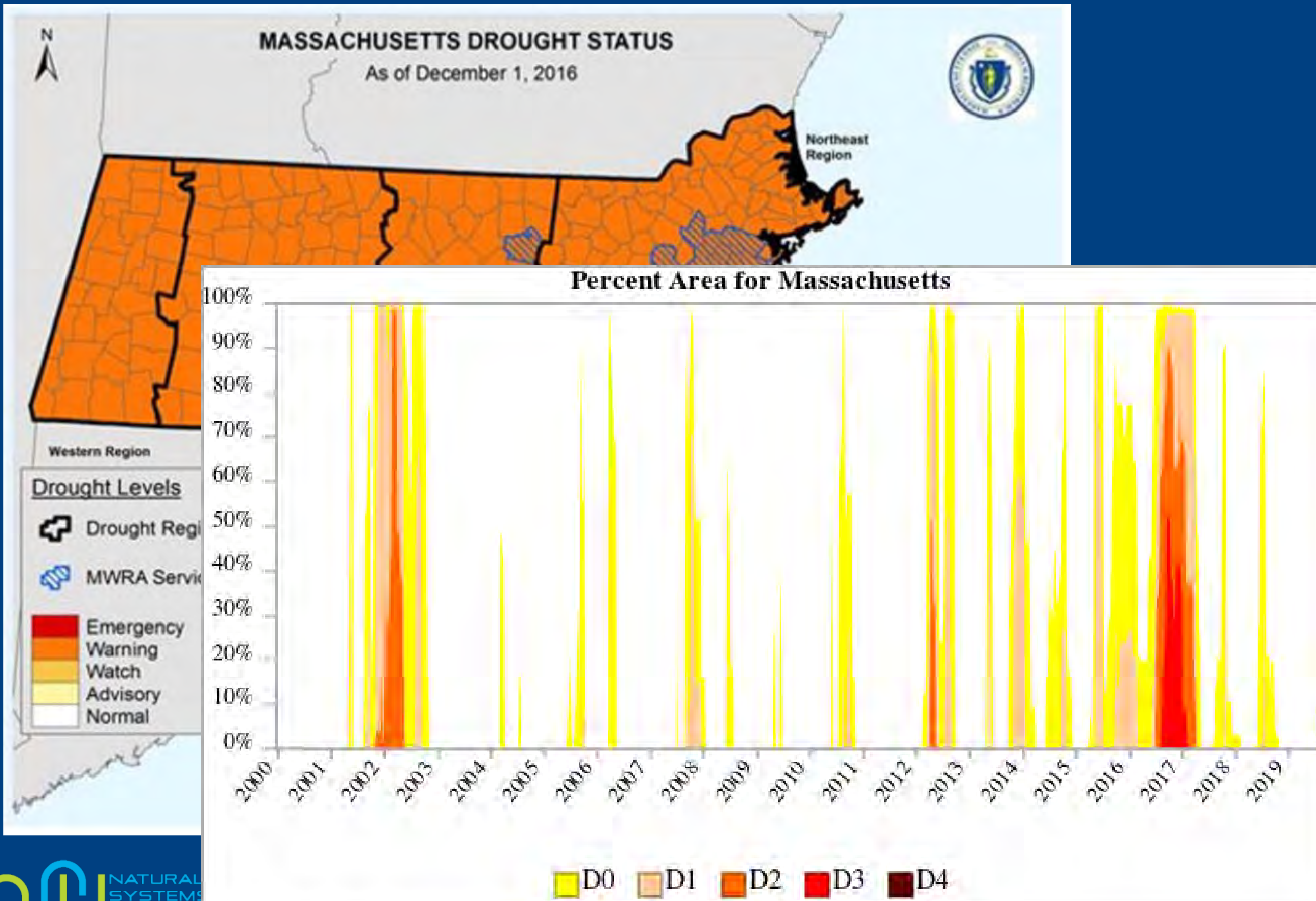
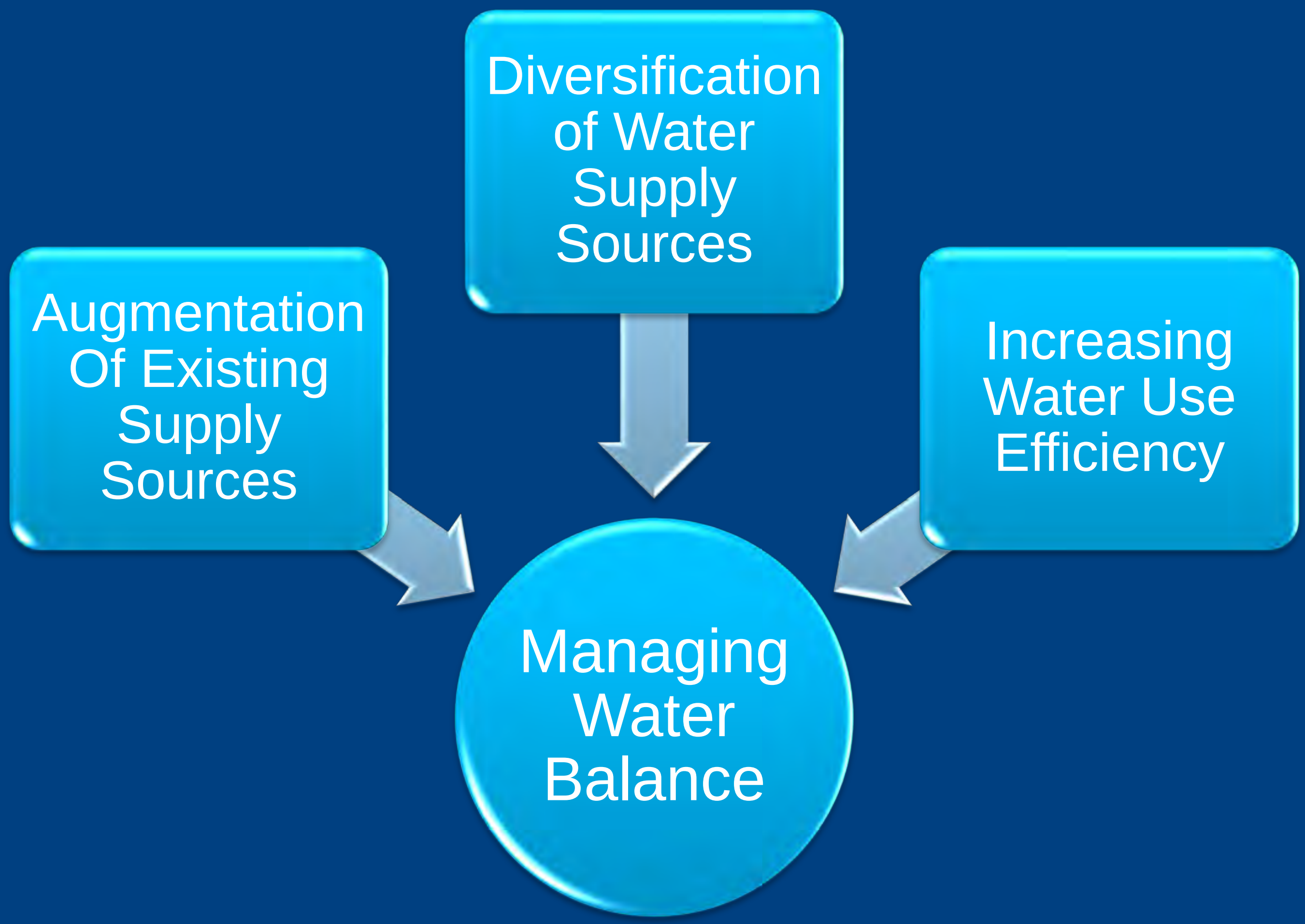
https://www.mass.gov/service-details/past-drought-declarations-maps-and-history

Drought Conditions in Massachusetts



Sustainable Urban Water Management



Source: Moglia, M & Cook, S.; 2019; Transformative Approaches for Sustainable Water Management in the Urban Century; *Water* 11, 1106; doi:10.3390/w11051106

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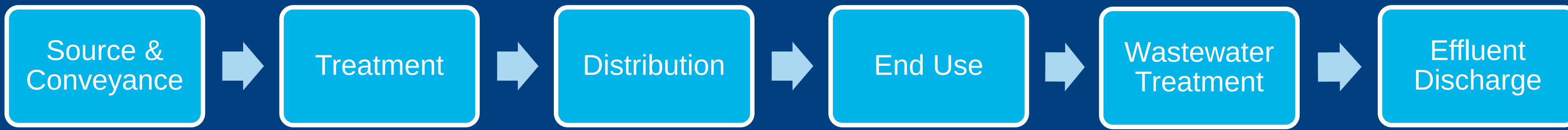
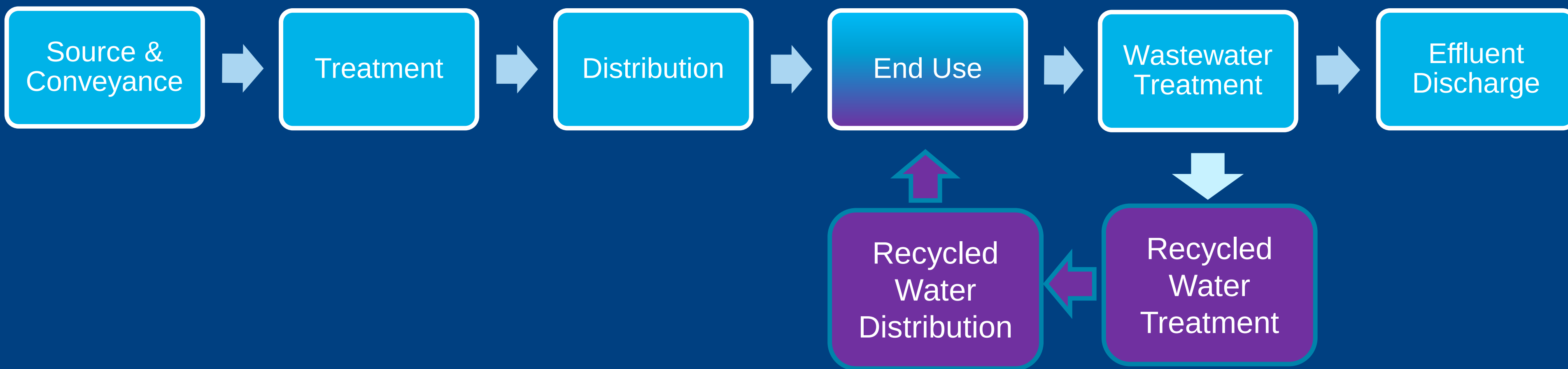
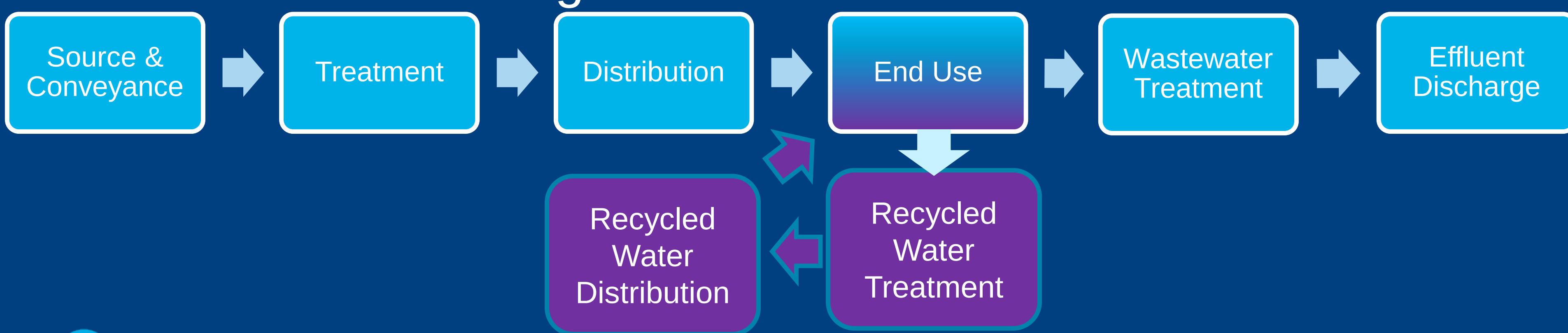
Centralized Water Management Without Reuse



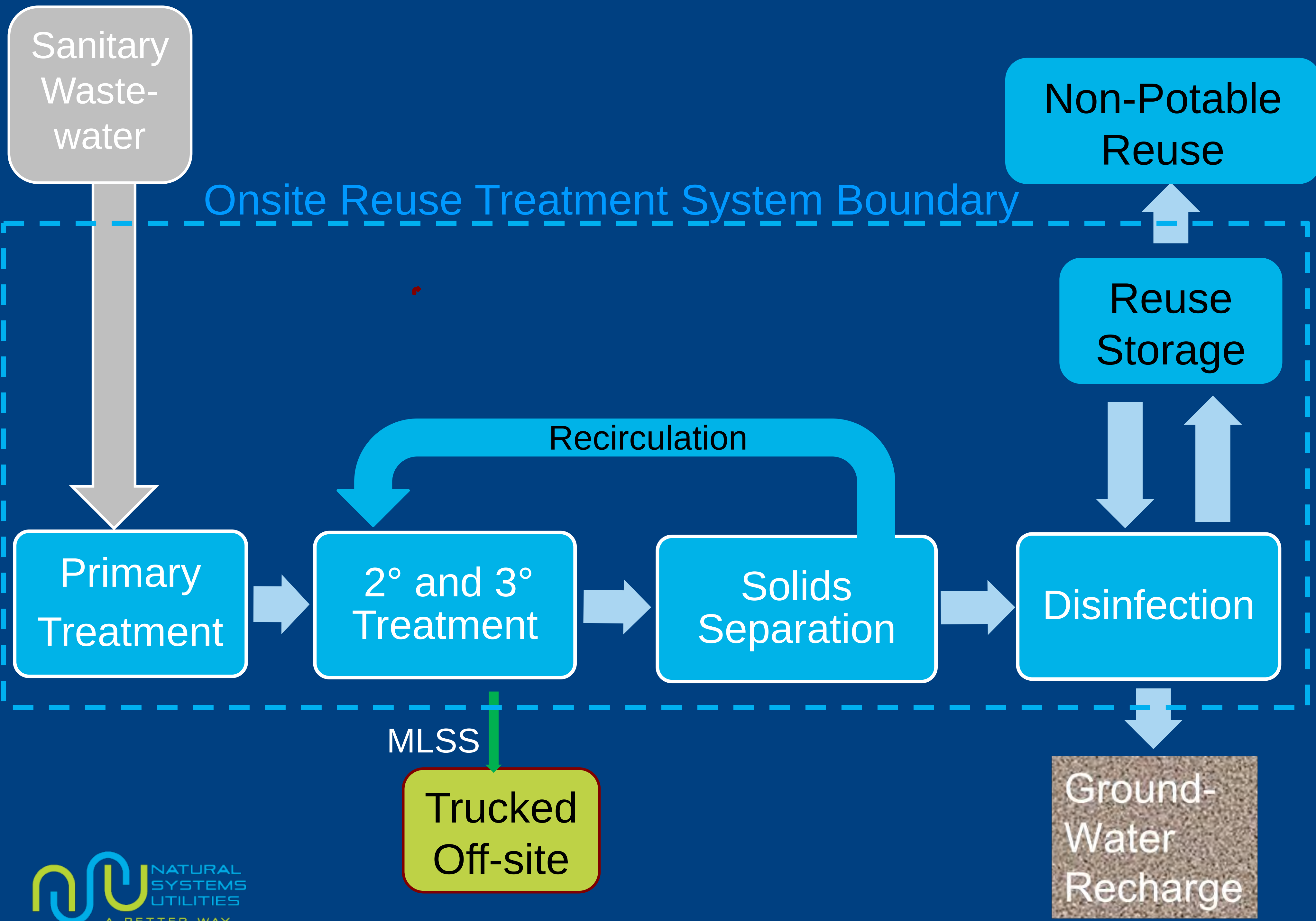
Centralized Water Management w/ Centralized Non-Potable Reuse



Centralized Water Management with Distributed Non-Potable Reuse



Typical Blackwater Reuse in Unsewered Area



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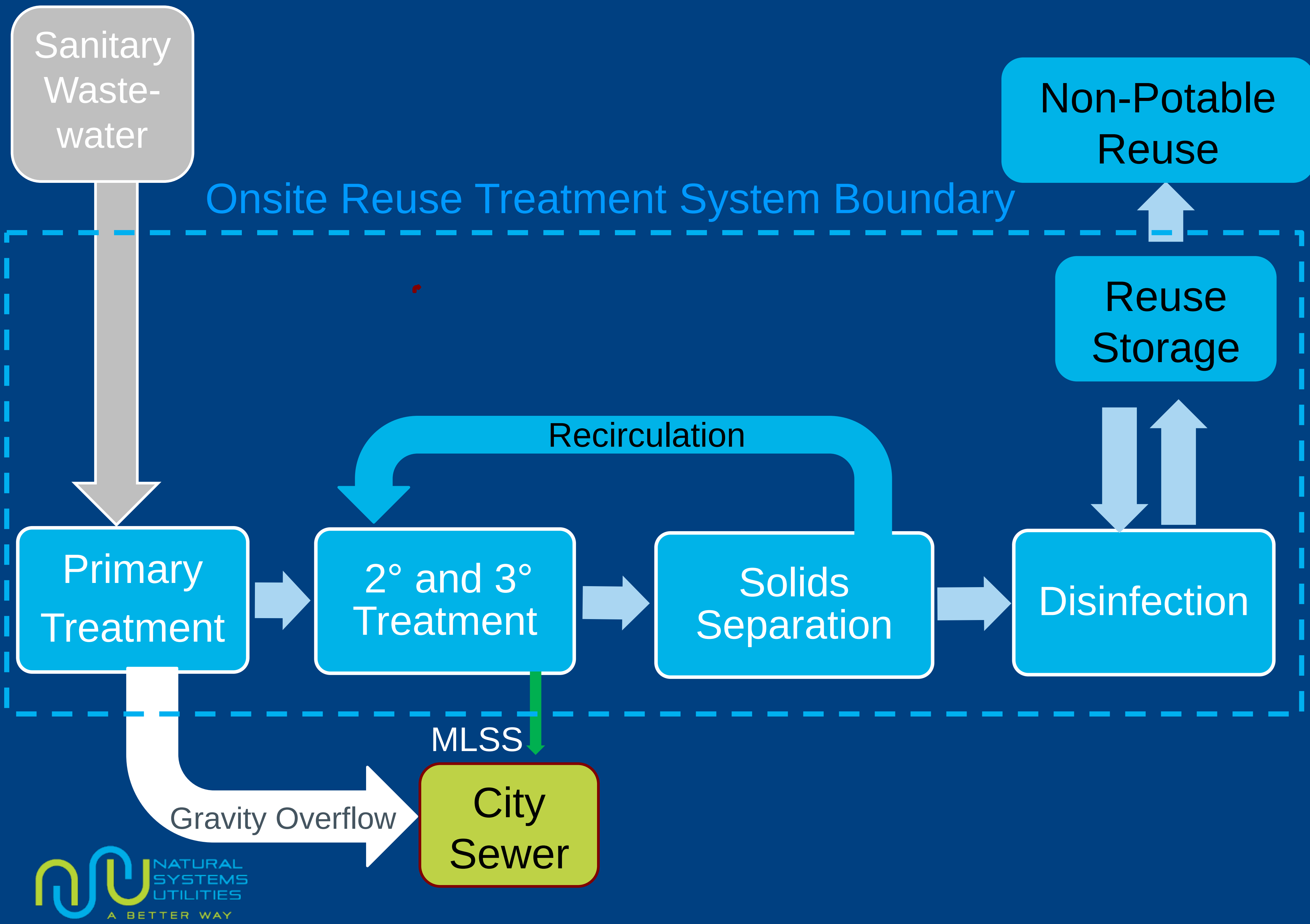
Typical Blackwater Reuse in a Sewered Area



Massachusetts Reclaimed Water Permit Program (314 CMR 20)

Allowed Uses for Class A Water in MA
Irrigation
Cooling Water
Toilet and Urinal Flushing***
Agricultural Use
Industrial Process Water
Commercial Laundries and Carwashes
Snowmaking
Fire Protection
Creation of Wetlands & Recreational Impoundments

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*** Excluding Single Family Homes, townhouses, and 2 & 3 family houses, where residents may have access to plumbing for repair or modification.

Example of Massachusetts Reclaimed Water Quality Requirements

Parameter	Class A Requirements
pH	6.5 – 8.5
Biochemical Oxygen Demand (5 day)	<10 mg/L
Total Suspended Solids	<5 mg/L
Total Nitrogen	<10 mg/L
Turbidity	2 NTU*
Fecal Coliform	Not Detectable**
Other Parameters specified by the DEP	To be determined

Notes:

* Less than average of 2 NTU within a 24-hour period, cannot exceed 5 NTU more than 5% of the time with a 24 hour period, and cannot exceed 10 NTU at any time.

**Median of no detectable fecal coliform/100 ml over continuous seven-day sampling periods, not to exceed 14 /100 ml in any one sample

Regulatory Initiatives: Public Health Protection through Advocacy. Creating and Guiding Regulatory Changes in Water Across The Country

NWRI National Water Research Institute

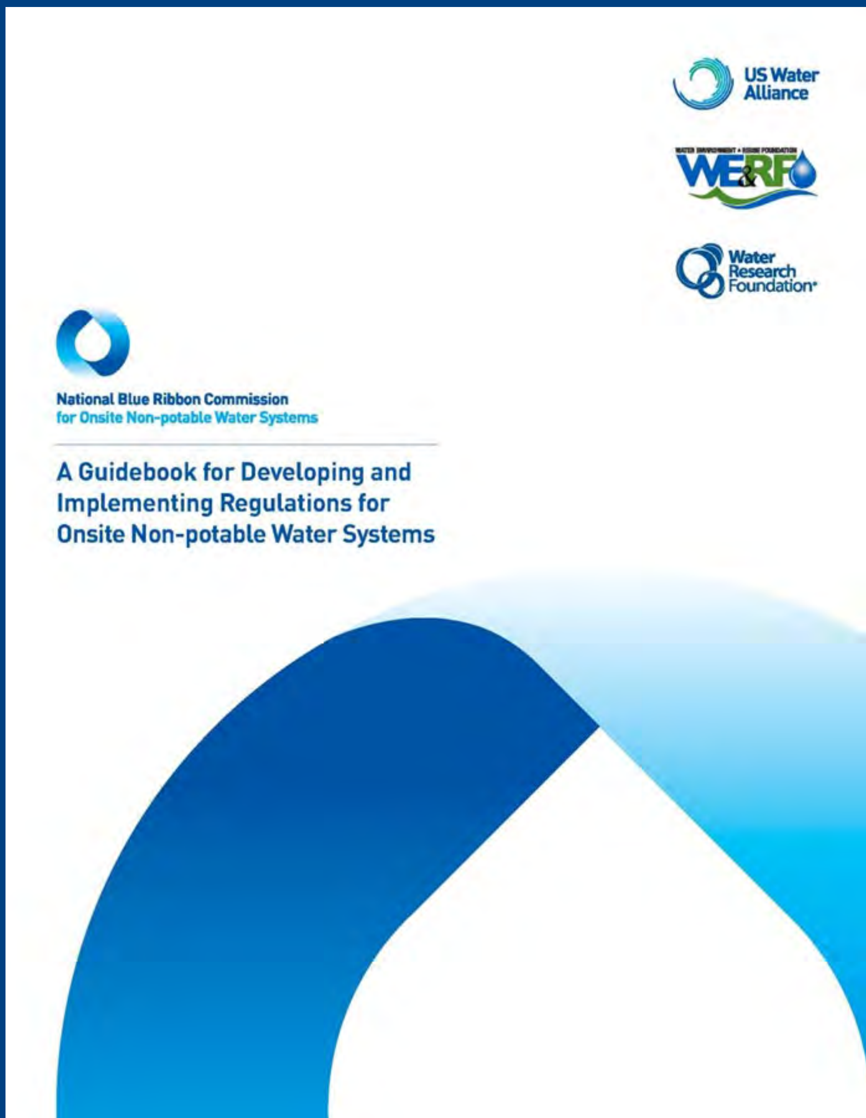
National Blue Ribbon Commission for Onsite Non-potable Water Systems

NYC Environmental Protection

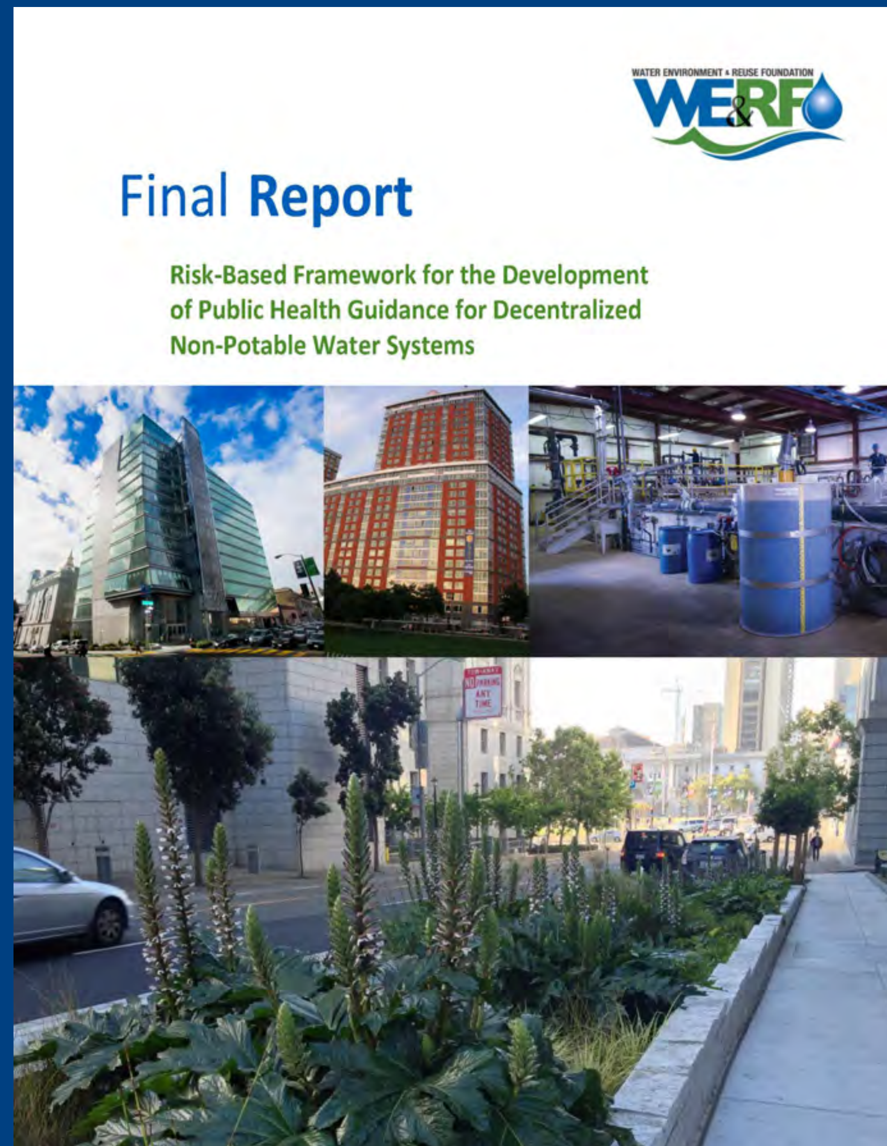
San Francisco Water Power Sewer

Services of the San Francisco Public Utilities Commission

Risk-Based approach to Public Health Protection for Non-Potable Water Systems



(2017)



(2017)

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Traditional Reuse Process Performance Monitoring

Daily Fecal Indicator Organisms (FIOs)

- *"FIOs may not be present in potential source water for a non-potable system.*
- *FIOs are not necessarily representative of all pathogen groups.*
- *Grab samples analyzed for FIOs cannot be used for continuous monitoring.*
- *FIOs are more difficult to measure consistently than other surrogate parameters."*

Source: WERF (2017) Risk-Based Framework for DNW Systems, page 49

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Risk Base Framework Focuses on:

- *Performance-based $\log_{10}$ reduction targets (LRTs) for the treatment of pathogens.*
- *Design to achieve the LRTs.*
- *Consistent management and monitoring practices.*
- *Consistent permitting and reporting practices.*

Source: WERF (2017) Risk-Based Framework for DNW Systems, page ix.

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Pathogen Concentration Reduction Using Base Ten (10) Logarithms

1 log : 10^{-1} or 90% removal

2 logs : 10^{-2} or 99% removal

3 logs: 10^{-3} or 99.9% removal

4 logs: 10^{-4} or 99.99% removal

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Performance-based treatment $\log_{10}$ reduction targets (LRTs)

- *Use surrogates (to address viral, bacterial, and protozoan pathogens)*
- *Are based on the source water and non-potable end uses for those source waters*
- *Provide a risk benchmark that we accept for both drinking and recreational waters (i.e., a tolerable risk from one infection per 10,000 and one infection per 100 people per year, respectively).*

Source: WERF (2017) Risk-Based Framework for DNW Systems

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Source: WERF (2017) Risk-Based Framework for DNW Systems

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Possible Reference Pathogens

Pathogen Group	Domestic Wastewater	Graywater	Stormwater	Roof Runoff
Enteric Viruses	✓	✓	✓	
Enteric Bacteria	✓	✓	✓	✓
Parasitic Protozoa	✓	✓	✓	✓

Source: WERF (2017) Risk-Based Framework for DNW Systems Table 3.2

Risk-Based Design Also Incorporates

- Fit for Purpose Water
- Multiple Barrier Design
- Log_{10} Reduction Values for Unit Processes

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Examples of Process Design and Control Features to Enhance the Reliability of a Water System and Applicable Management Category

Feature	Benefit
Alarm systems	Immediate notification of operator
Backup dispersal or discharge system	Redundancy of discharge capacity
Equalization of flows	Process stability and maximize non-potable water use
Fail-safe mechanisms	Automatic shutdown of a process or diversion of flow
Make-up water systems	Automatic addition of water from back-up supply

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Excerpted from WERF (2017) Risk-Based Framework for DNW Systems, Table 2-4

Selected Observed Values for Various Levels of the Inactivation of Enteric Bacteria in Filtered Secondary Effluent with Selected Disinfection Processes

		Dose for Corresponding Log10 Reduction Value			
Disinfection	***Unit*[A]**	***1 Log*$_{10}$**	***2 Log*$_{10}$**	***3 Log*$_{10}$**	***4 Log*$_{10}$**
Free Chlorine	*mg•min/L*	*0.4 – 0.6*	*0.8 – 1.2*	*1.2 – 1.8*	*1.6 – 2.4*
Ozone	*mg•min/L*	*0.005 – 0.01*	*0.01 – 0.02*	*0.02 – 0.03*	*0.03 – 0.04*
Ultraviolet Radiation	*mJ/cm^2*	*10 – 15*	*20 – 30*	*30 – 45*	*40 – 60*

[A]Abbreviations:

- mg•min/L = Milligram-minutes per liter.
- mJ/cm^2 = Millijoules per square centimeter

Source: 2017; Risk-Based Framework for DNW Systems; Table 4.5

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Example Treatment Process Log_{10} Reduction Credit Examples

Treatment Process	Log_{10} Reduction Credits (Virus/Protozoa/Bacteria)
Microfiltration or Ultrafiltration	0/4/0
Membrane Bioreactor	1.5/2/4
Reverse Osmosis	Up to 2/2/2
Ultraviolet Light Disinfection	Up to 6/6/6
Chlorine Disinfection	Up to 5/0/5
Ozone Disinfection	Up to 4/3/0

*Source: Adapted from Table 3 in Blue Ribbon Commission, 2017, A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems – See source for complete table, comments and notes.

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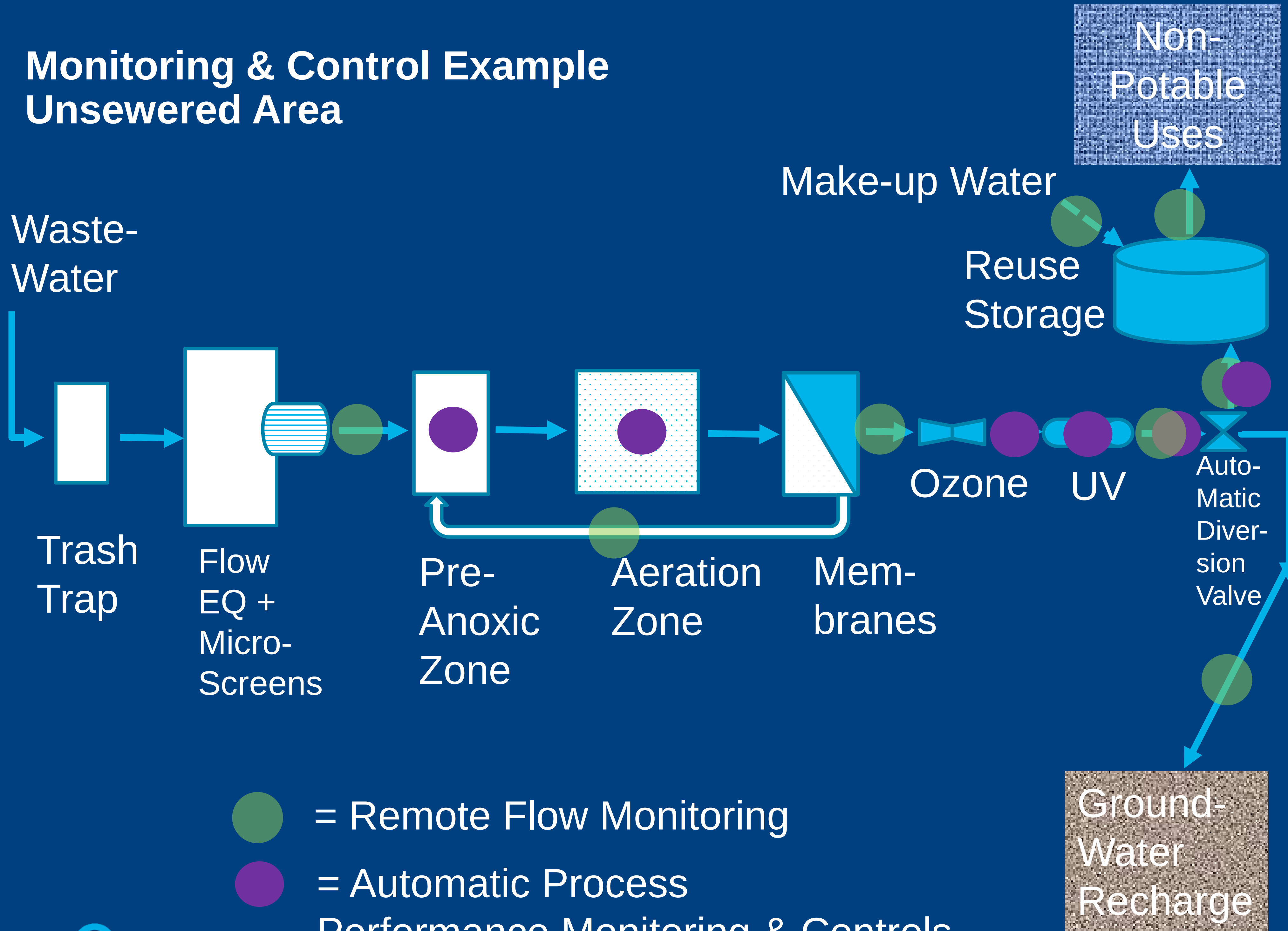
Log_{10} Reduction Example - Groundwater Discharge System

Component	Virus	Protozoa	Bacteria
MBR	**1.5**	**2**	**4**
Ozone	**0.3**	**0**	**0**
UV	**3.5**	**6**	**3.5**
Total	**5.3**	**8**	**7.5**
Indoor Use Target	**8.5**	**7.0**	**6.0**

Log_{10} Reduction Example - Enhanced Ozone and UV system

Component	Virus	Protozoa	Bacteria
MBR	1.5	2	4
Ozone	1.5	0	0
UV	6	6	6
Total	9.0	8	10
Indoor Use Target	8.5	7.0	6.0

Monitoring & Control Example
Unsewered Area



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Monitoring & Control Example
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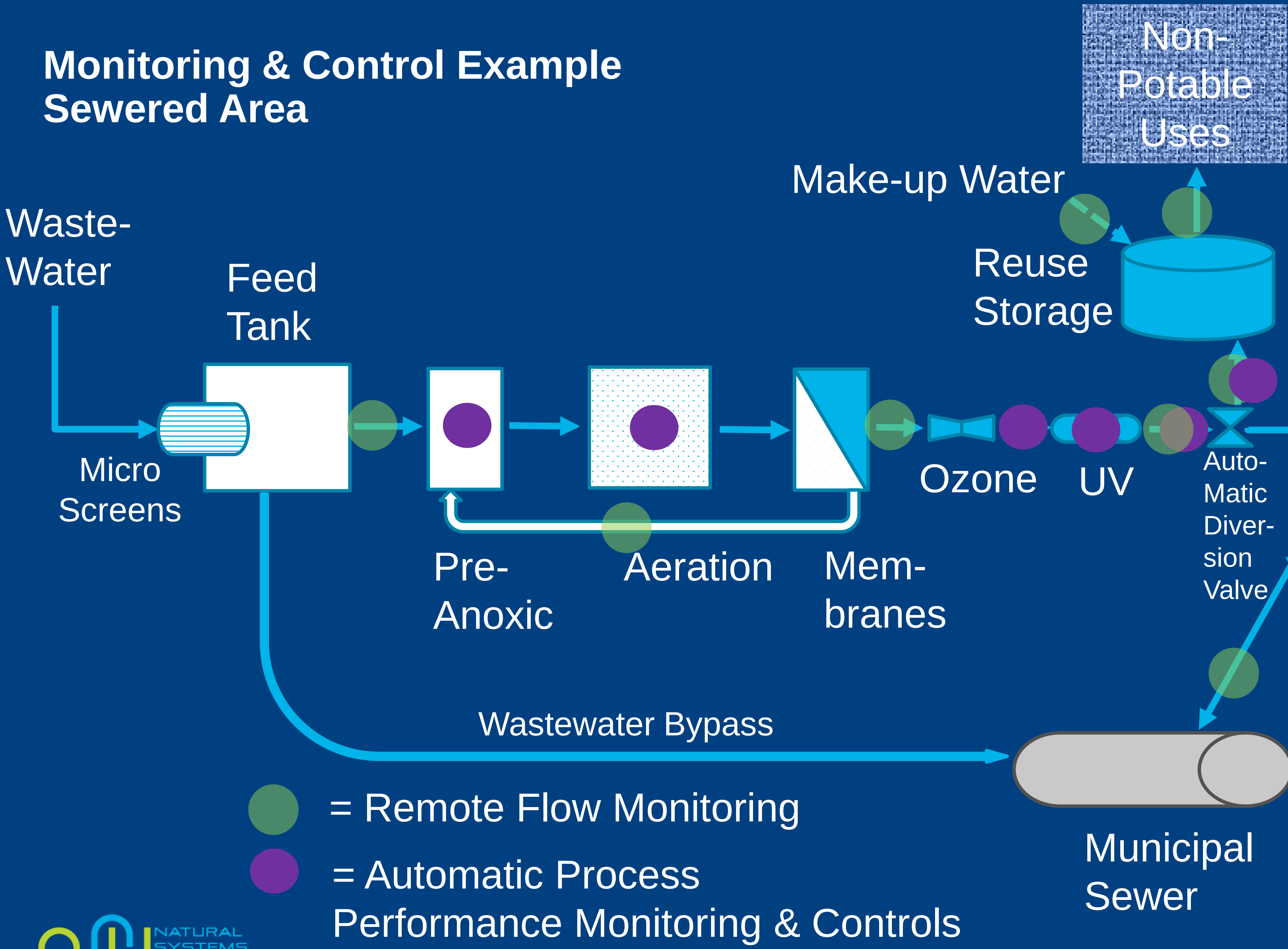

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Management, Monitoring & Reporting Considerations

Management	Monitoring	Reporting
Validation & Control	Field Verification	Data
Automation	Continuous Verification	Compliance
Feedback Loops	Alarms	

Examples of Parameters Used for Continuous Monitoring

Unit Process	Critical Control Point Examples
Membrane bioreactor	Trans-membrane pressure; flow rate; & turbidity
Ozone	Oxidation-reduction potential (ORP)
Ultraviolet Disinfection	UV transmittance

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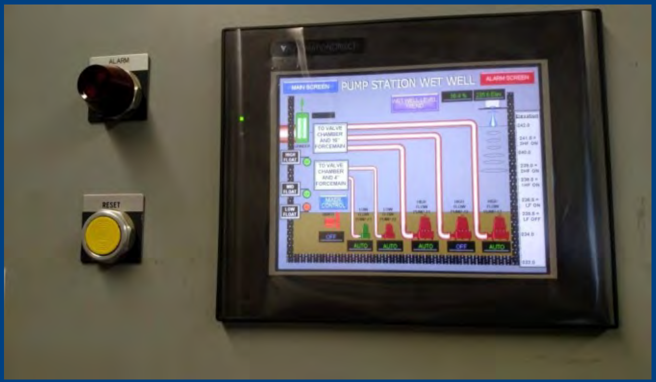
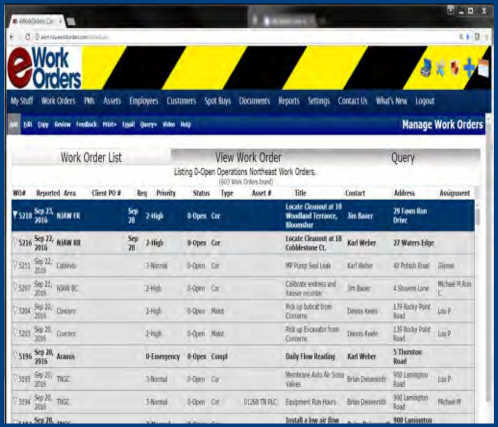
Source:Table 6-4:

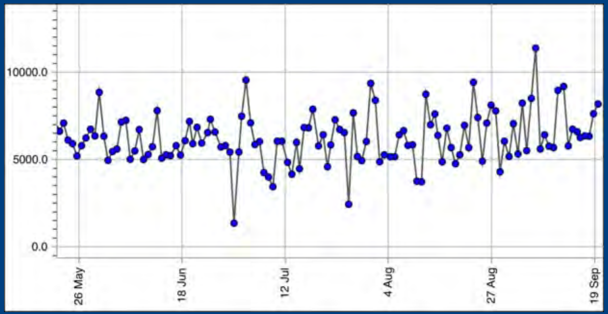
How We Do It –
Secure Remote Access = Efficient Operation, Maintenance and Asset Management



Programmable Logic Control (PLC) & Supervisory Control and Data Acquisition (SCADA)



Computerized Maintenance Management System (CMMS)



Digitized Daily Rounds (LogCheck)

Proposed Framework

Design & Management Plan

Permit Application & Report Submission

Construction & Commissioning

Operational Monitoring

Reporting

Adapted rom Figure ES-1

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Questions?

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