

Is there a Distributed Reuse System in your Future

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Outline

- Opportunities and Challenges
- Research Results

Executive Order 13514

(June 2009)

- 25% improvement in water efficiency
 - Wastewater reuse
 - Stormwater and rainwater harvest
- Net-zero buildings by 2030
- 50% recycle and waste diversion
 - Energy recovery from digestion

Regulatory Issues

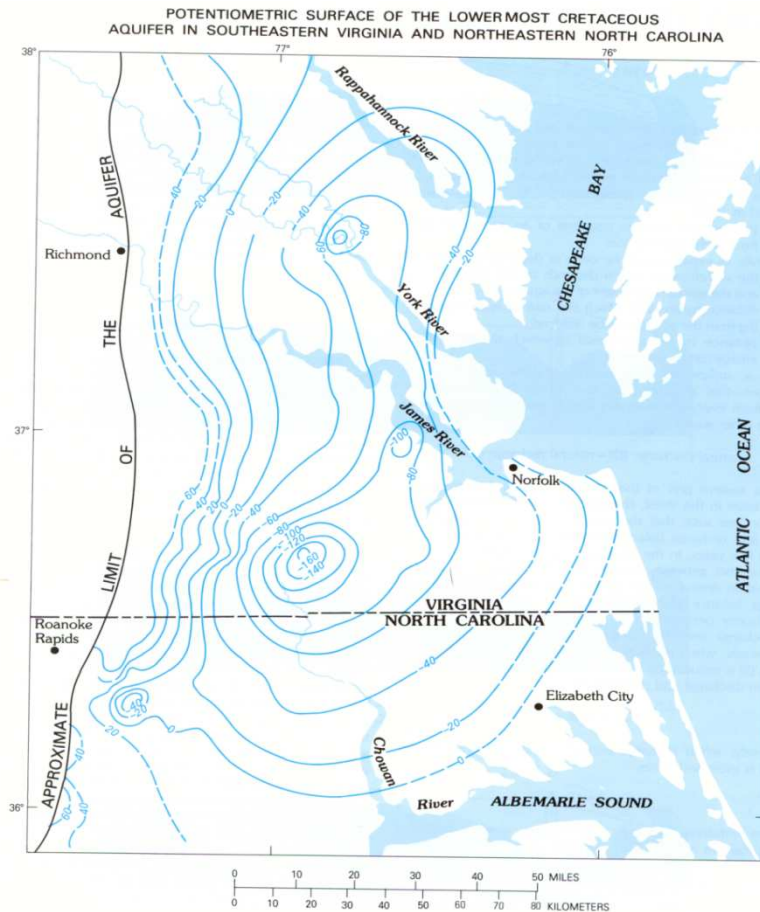
- USEPA
 - Consistent with PL 92-500
 - Guidelines for Land Application and Reuse
- State
 - NCAC 02t and 02u rules
 - State building code - IgCC

Reuse Guidelines

- Guidelines because NO mandate
- Variety of end uses
- Recent interest in direct and indirect potable use
- This document is available via the internet:
- <http://www.waterreuseguidelines.org>

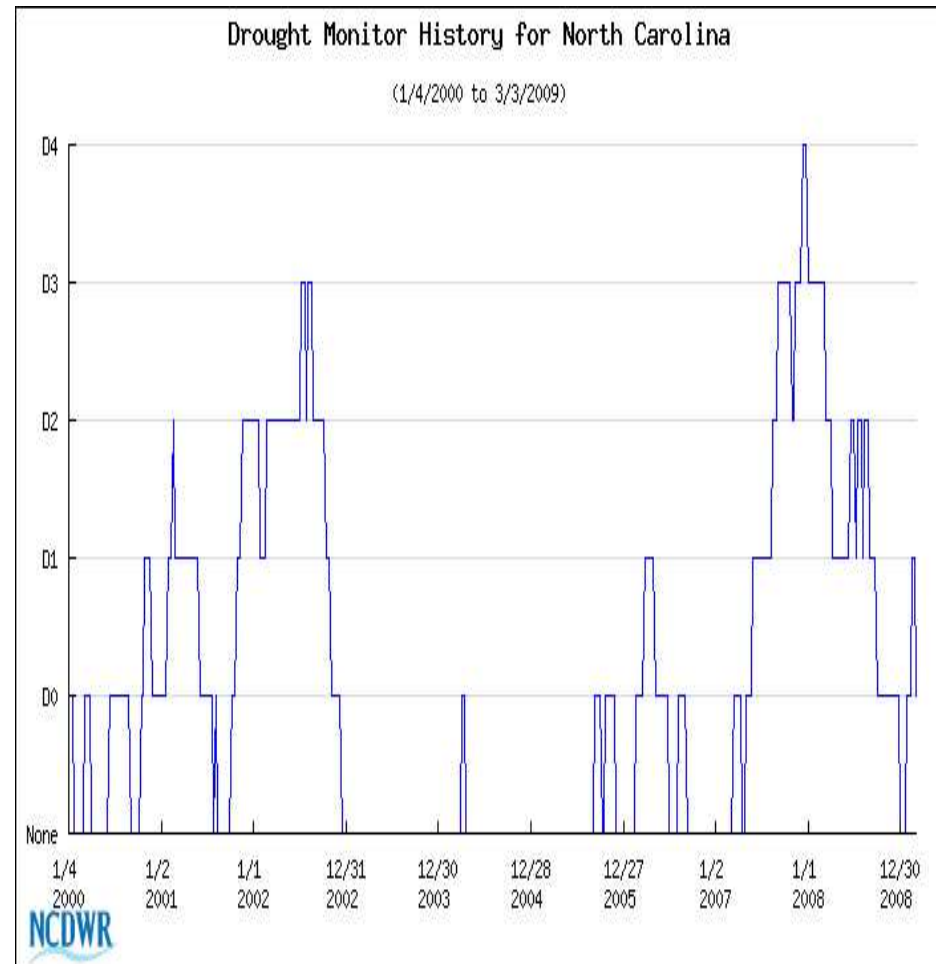


Groundwater Potentiometric Surface Data – Dwindling Supplies



Drought History

- Significant stress on water systems through decade
- Increasing population pressures expected



Reuse and Non-Potable Use Implications

- Environmental and Public Health Consequences
 - Discharge elimination
 - Reliable supply of high quality water-potable demand management
 - LEED
 - Important tool, provided health concerns addressed
- Resource Allocation Consequences
 - Extends water supplies
 - Reduces energy demands on potable system
 - Saves Dollars
 - Important tool to optimize resource management provided sustainability addressed

Health Concerns

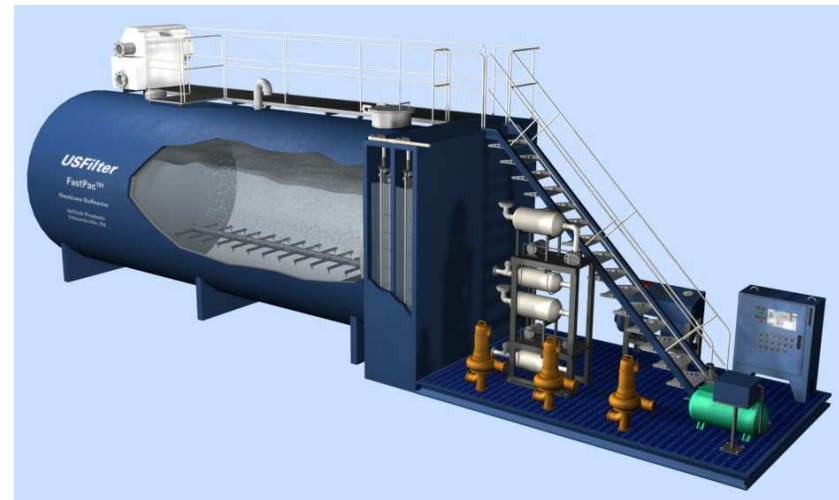
- Public Health Concerns drive reuse efforts
- Microorganism levels reduced to detection
- Advanced treatment and Multi-barrier disinfection processes where exposure high
 - Chemical (chlorine, ultraviolet light, Peracetic acid)
 - Barriers (microfiltration)

Incidence of problems

- Primary effluent – irrigated lands in Mexico and Israel health issues documented
- Secondary effluent – no documented incidence of disease
- Advanced Treatment – No documented incidence of disease

Sources of Non-Potable Water

- Wastewater and graywater
- Harvested rainwater
- Stormwater
- Drainage water
- Water plant backwash



Optimizing Current Reuse Practices

First Steps to Evaluate / Implement Reuse

- I. **Reclaimed Water Demand Projections – Initial Planning Period (Planning Horizon of 25 Years)**
 - a. Irrigation Demands (Landscape, Lawns, Common Areas, etc...)
 - b. Industrial Demands (Chiller / Cooling Water Makeup, Boiler Feed, Washdown, etc...)
 - c. Indoor Demands (Toilet Flushing, Courtyards, Dual Plumbing, etc...)
 - d. Fire Protection
 - e. Other Uses (Aesthetics, Fountains, Ponds, etc.)
 - f. Continuous vs. Seasonal Operations
 - Average Daily Flows & Pressures
 - Peak Daily Flows & Pressures
 - Daily Demand Curves
 - Demand Projection Curves

First Steps to Evaluate / Implement Reuse

- II. Reclaimed Water Quality**
 - a. Effluent Treatment Requirements for Planned Uses
- III. Establish Infrastructure Needs**
 - a. Reclaimed Treatment Considerations / Alternatives
 - b. Reclaimed Storage
 - c. Reclaimed Distribution System
- IV. Preliminary Design of Reuse Infrastructure**
 - a. Treatment System(s)
 - b. Nutrient Management Plans
 - c. Storage & Distribution System
 - Hydraulic Model
 - Backflow Prevention and Cross Connection Control Program
 - Standard Reuse System Details and Specifications
 - d. Irrigation Systems
 - e. Hydraulic and Nutrient Loading Considerations
 - f. Industrial Systems
 - g. Indoor Systems

First Steps to Evaluate / Implement Reuse

V. Capital Improvement Program

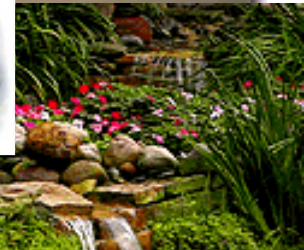
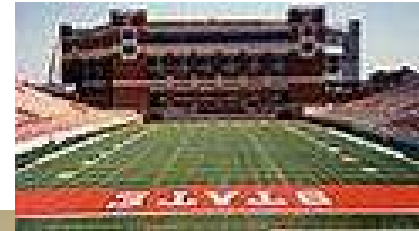
- a. Preliminary Project Cost Estimates
 - i. Treatment Alternatives
 - ii. Distribution System Alternatives
 - iii. Storage
- b. Reclaimed User Systems
- c. Five Year Capital Improvement Program

VI. Public Education / Outreach Needs

- a. Work Sessions with Community Leaders
- b. General Public (Staff / Students) Education / Outreach
- c. End-User Training and Education

Use of Reclaimed Water - Irrigation

Golf Courses, Residential Lawns,
Agricultural Sites, Cemeteries, Parks,
School Grounds, Commercial / Industrial
Site Grounds, Landscape Areas,
Roadways, Medians and Other Similar
Areas



Additional Uses for Reclaimed Water

- Industrial purposes such as process or cooling water;
- Aesthetic purposes such as decorative ponds or fountains, fire protection, dust control, street cleaning and other similar uses
- Bulk reuse programs



Emerging Uses of Reclaimed Water

Fire Protection

Urinal / Toilet Flushing

Chillers / Cooling

Pollution Abatement

Commercial / Industrial
Buildings, Hotels or Motels

Laundry



Irrigation of Food Chain Crops

- Principal Concerns – Transmission of Pathogens CEC (PCP/Pharmaceuticals)
- Multi-barrier Treatment / Disinfection
 - Tertiary quality effluent (biological treatment, filtration)
 - Membranes
 - Chlorination
 - Ozonation
 - Ultraviolet Light
 - Advanced Oxidation Procedures (AOPs)



Wetland Augmentation

Natural wetlands – Hardwood and Pine Flats

Degraded via clear-cut, ditching, drained, or managed

Benefits such as wildlife habitat; passive and active recreation, boardwalks, bird watching, creature watching, public / schoolchildren education.



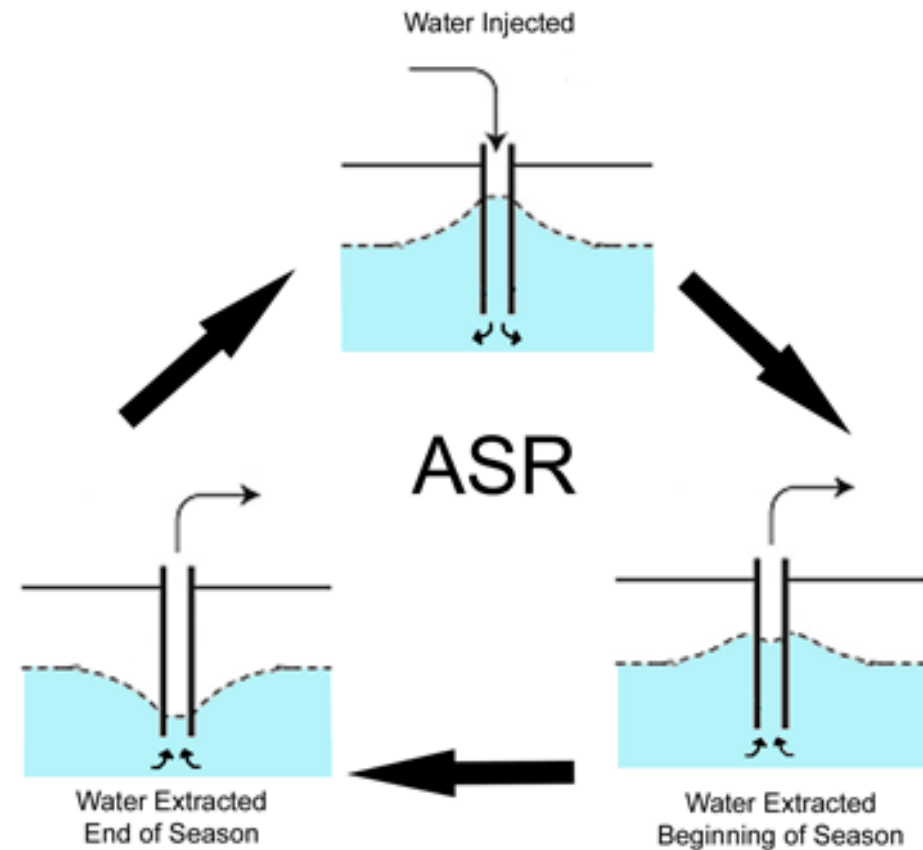
Stream Augmentation

Stream Benefits such as enhancement of degraded biological habitat - 303d listed streams (WQ or Habitat); reclaimed water in streams that are subject to "drying up"; loss of habitat – mussels, fish, etc., public parks, public education, water features. Mitigation of 305b impairments.



ASRs & Groundwater Recharge

- ASRs – Opportunities to store and recover hundreds of millions of gallons of water
- Coastal Barriers for Saltwater Intrusion
- Slow Rate / High Rate Infiltration Systems – Aquifer Recharge
- Statutory Restrictions
- **Caution – solubility**

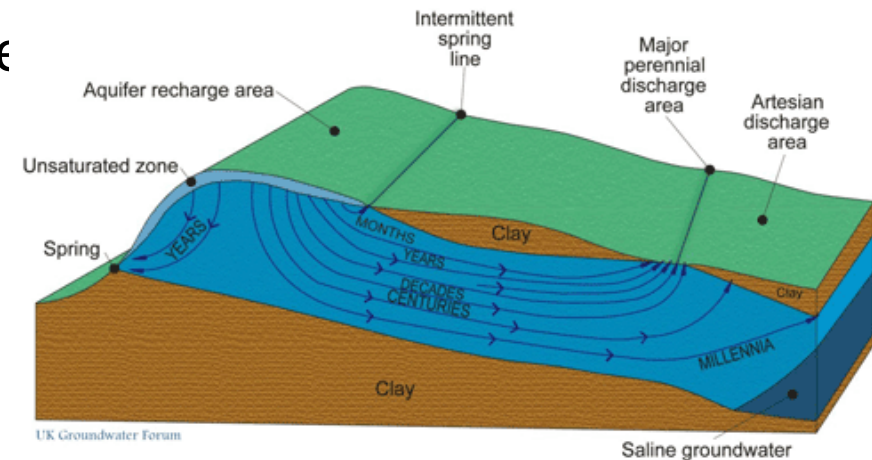


Planned Direct and Indirect Potable Reuse

(through surface supply and groundwater)

Few National Examples (Clayton Co, GA;
Water Factory 21, OCWD, CA), AZ

- Generally, no more than 25% indirect feed for direct reuse (treatment plant through wetland to water treatment plant)
- Indirect – natural buffers – surface or groundwater
 - Twelve month travel time between infiltration / withdrawal
 - Minimum 2,000 foot between infiltration / withdrawal



Water Quality Concerns

- Intended Use of reclaimed or harvested water drives issue
- Risk Based Management
- Treatment Requirements
 - Constituents of concern (BOD, N, P, Na, coliform, virus)
 - Treatment and Disinfection
 - Microbiological
 - Organic
 - Nutrients and salts
 - turbidity

Standards

- No federal reuse standard
- State rule or guideline
 - Generally for MUNICIPALLY TREATED wastewater
 - Treatment requirements
 - Water Quality Standards
 - BOD, TSS, Turbidity, Indicator Organisms, Nutrients
- NSF/ANSI 350 and 350-1 *Onsite residential and commercial reuse treatment systems*
 - Equipment requirements
 - Treatment levels
 - BOD, TSS, Turbidity, Indicator Organisms, Nutrients

Some Water Quality Rules

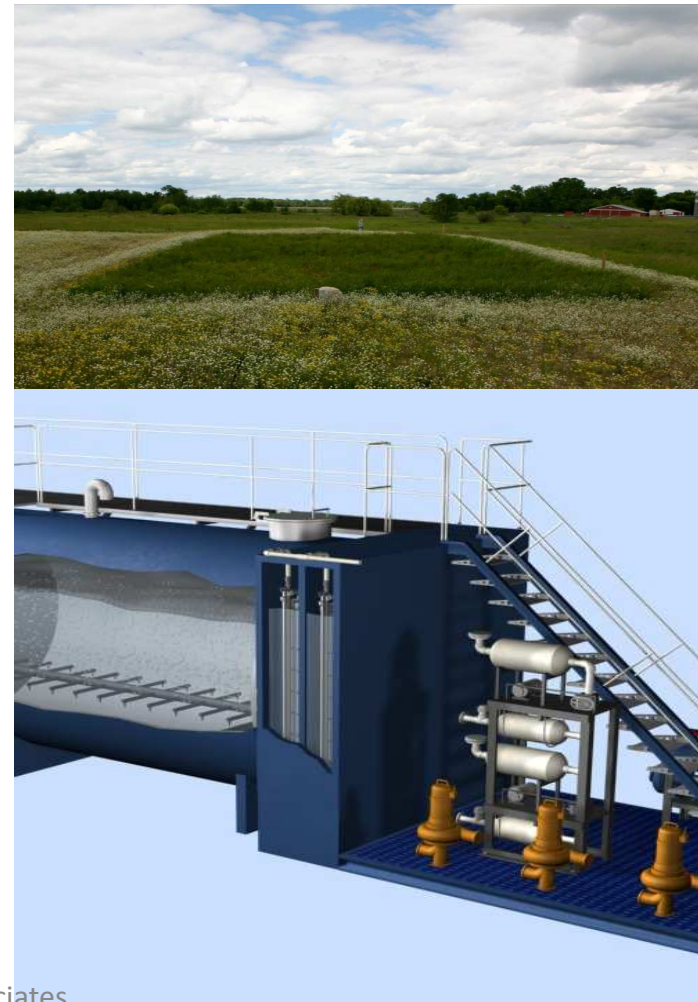
- 15 A NCAC 0 2U (reclaimed water), 2T - irrigation
- 18 Arizona Administrative Code 11 A3 (B)
 - Classes A+, A, B+, B, C
 - Type 1, 2 or 3 permit
- NSF 350 and 350-1 (Non-Potable water use)
- NO EPA STANDARDS for Non-Potable use
 - No congressional mandate
 - Guidelines only

Selected Standards

Jurisdiction	Turbidity	BOD	TSS	Coliform	C. perfringens	Coliphage
CA	2	NS (adv oxidation)	NS (adv filtration)	2.2		
FL		20	5	ND		
NC	5	10	5	14	-3 log	-4 log
VA	5	10	5	14		
NYC	2	10	10	2.2		

Treatment Technologies

- Advanced levels of treatment possible with complex and simple technologies
 - High quality water
 - Fit for purpose
 - Rule compliant
 - MANAGEMENT ESSENTIAL
 - Dr. Pradhan will discuss



NSF/ANSI 350

- American National Standard
- Residential and commercial treatment systems
- Sources; graywater and combined wastewater
 - Graywater: laundry and bathing, excluding toilet and kitchen.
 - Combined: blackwater and graywater.
- Non-potable effluent uses
 - Indoor; toilet and urinal flushing.
 - Outdoor; surface and subsurface irrigation.

NSF/ANSI 350

- Residential wastewater; Up to 1500 gpd
 - Laboratory testing with actual wastewater.
- Graywater; Up to 1500 gpd
 - Laboratory testing with synthetic wastewater; bathing, laundry, or both
 - Exception; commercial laundry water
- Systems exceeding 1500 gpd, and commercial laundry
 - Field evaluation using actual building wastewater.

350 and 350-1 Standards

350

- Domestic wastewater and graywater used indoors
 - Chemical
 - Biological
 - Physical
 - Indoor uses and unrestricted outdoor use

350-1

- Graywater
 - BOD and TSS
 - Outdoor use only
 - Buried/subsurface drip

NSF/ANSI 350 Effluent Criteria

Standards

Parameter	Class R	Class C
CBOD ₅	10 mg/L (25)	10 mg/L (25)
TSS	10 mg/L (30)	10 mg/L (30)
Turbidity	5 NTU (10)	2 NTU (5)
E. coli	14 MPN/100 mL (240)	2.2 MPN/100 mL (200)
pH	6.0 – 9.0	6.0 – 9.0
Chlorine	0.5 - 2.5 mg/L	0.5 - 2.5 mg/L

Use

- Indoor
 - Toilet flush
 - Laundry (?)
- Outdoor
 - Unrestricted irrigation
 - Pressure washing
 - De Minimis discharge

NSF 350-1 Criteria

Sources

- Laundry only
- Laundry and shower/lavatory
- Outdoor irrigation only
 - Subsurface drip (3-6 in typ)
 - Covered surface drip (1 in mulch cover)

Standard

Measure	Standard
CBOD5	25 mg/l
TSS	30 mg/l

NYC



- Decentralized reuse in highly urbanized area
- LEED Platinum
- Green roof filters and captures stormwater
- Wastewater and stormwater treated for reuse
 - Toilet flushing
 - Cooling tower supply
 - Irrigation of park
- 48% reduction in potable water consumption
- 56% reduction in wastewater discharge

*Reference – Battery Park City Authority
Manhattan Borough, NYC, The Solaire
– Alliance Environmental, LLC*

Wilkerson Park, Wake Co

Indoor reuse and
SAS

Building Code
approval

MBR

treatment/Pressure
manifold/Chamber

NO REDUCTION

HQW achieved

Award winner

On-line turbidity
monitor



	BOD	TS	TN	coli	Turbidity (5 min/3 yr)
RQD	10	10		14	5
Ave	ND	ND	4	ND	.05
Max	7	ND	5	ND	.08

ICC and USGBC

- IgCC (Green Code, 2012)
 - Water efficiency provisions
 - Ch's 3, 7, and 9
- ICC (2015 Code)
- LEED Building
- LEED ND

LEED Certification

Leadership in Energy and Environmental Design



LEED for New Construction and Major Renovation 2009 Project Scorecard

Yes	?	No		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Water Efficiency	10 Points
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Prereq 1 Water Use Reduction, 20% Reduction	Required
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 1.1 Water Efficient Landscaping, Reduce by 50%	2
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 1.2 Water Efficient Landscaping, No Potable Use or No Irrigation	2
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 2 Innovative Wastewater Technologies	2
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 3.1 Water Use Reduction, 30% Reduction	2
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 3.2 Water Use Reduction, 40% Reduction	2
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Project Totals (Certification Estimates)	110 Points
Not Certified			Certified: 40-49 points Silver: 50-59 points Gold: 60-79 points Platinum: 80+ points	



IgCC – Ch 3: Jurisdiction

- Water Use Provisions
- Local Jurisdiction determines applicability for Municipal Reuse Systems (Table 302.1)
- Ref: ASHRE/USGBC/IES Standard 189.1 design of High Performance of Green Buildings

Ch 7: Water Resource Conservation, Quality and Efficiency

- 702 – fixtures
 - 702.7: municipal reclaimed water; where available and required in 302.1 reclaimed water shall be supplied to:
 - Water closets
 - Water supplied urinals
 - Water supplied trap primers, and
 - Applicable industrial uses (NCDENR 0.2U defines these)
 - Accessible if less than 150% of distance to potable line

Section 704: Treatment Devices

- 704.3: Onsite reclaimed water system applicable to graywater and wastewater
- Water use in toilet and urinals or irrigation
AND SIMILAR APPLICATIONS
- NSF 350

Ch 7, section 706: Non-Potable Water Requirements

- 706.1: Scope – Use and application comply w/local laws, rules and ordinances
- 706.2: Signage – “Non-Potable water is used for... DO NOT DRINK”
- 706.3: Quality – Rules and regs in local jurisdiction or NSF 350

Section 707 – Rainwater Collection and Distribution

- 707.11.5: Filtration – intended use
- 707.11.6: Disinfection – intended use
- 707.11.7.2: Materials NSF 61 if potable use

Section 708 – Gray Water Systems

- 708.2: Permits – Local jurisdiction
- 708.3: Potable connection - backflow protection
- 708.5.1 – Gray water irrigation –
 - Surface and subsurface irrigation
 - 24 Hr retention time

Section 709: Reclaimed Water Systems

- 709.2: Permits – Required!!!
- 709.3: Potable Connections – Protected
- 709.5: Applications – used IAW section 706 and local codes
- 709.1: Tests and Inspections
 - 709.10.1: testing make up piping and reclaimed system
 - 709.10.2: inspection and testing of backflow prevention assemblies IAW 312.10 IPC

Section 710: Alternative Onsite Nonpotable Water Sources

- 710.1: including but not limited to stormwater, RO reject water, foundation drain water, pool backwash shall be permitted if properly treated for intended use and IAW local jurisdiction requirements

Ch 9: Commissioning, O and M

- 901.1: Scope - Pre and Post occupancy issues
- 903.1: Commissioning –
 - Registered design professional requirements
 - Commissioning plan
 - 904.3: Building O and M
 - Record documents
 - O and M manual shall be provided to owner

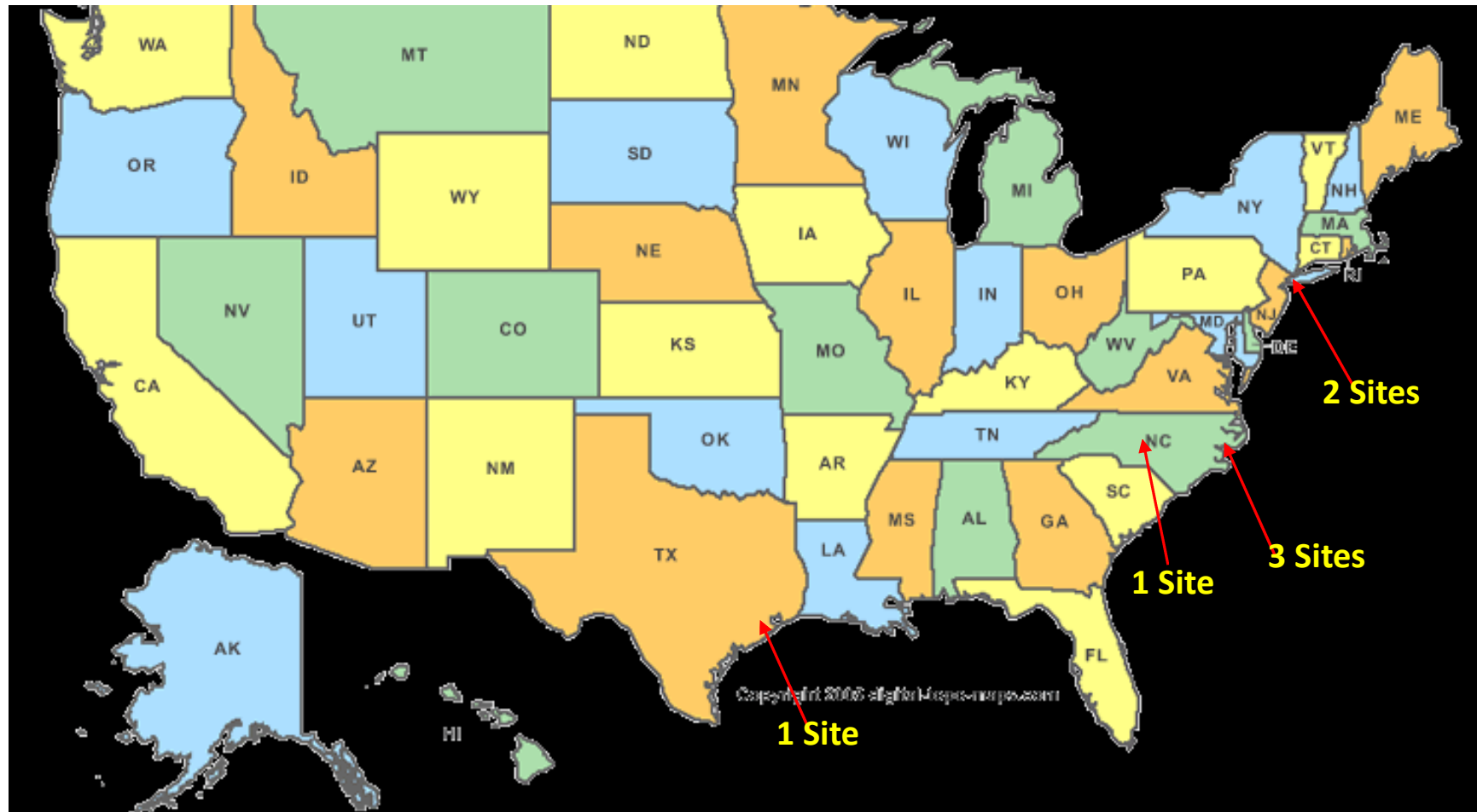
Additional Information and NC/CDC/NEHA Research Report

- Water Environment Research Foundation (WERF) funded research project ***When to Consider Distributed Systems in Urban and Suburban Areas***
- Products
 - Detailed case study summaries, white papers
 - MCDA-based decision-support tool
 - Database of case studies
 - Other targeted communications products (journal articles, presentations, etc.)
- Public access at www.werf.org and www.ndwrcdp.org

Project Objectives

- 1. Feasibility of using reclaimed water from decentralized systems as non-potable waters for rural and urban communities**
- 2. Possible impacts it could have in public health and the environment.**

Study sites



Study sites

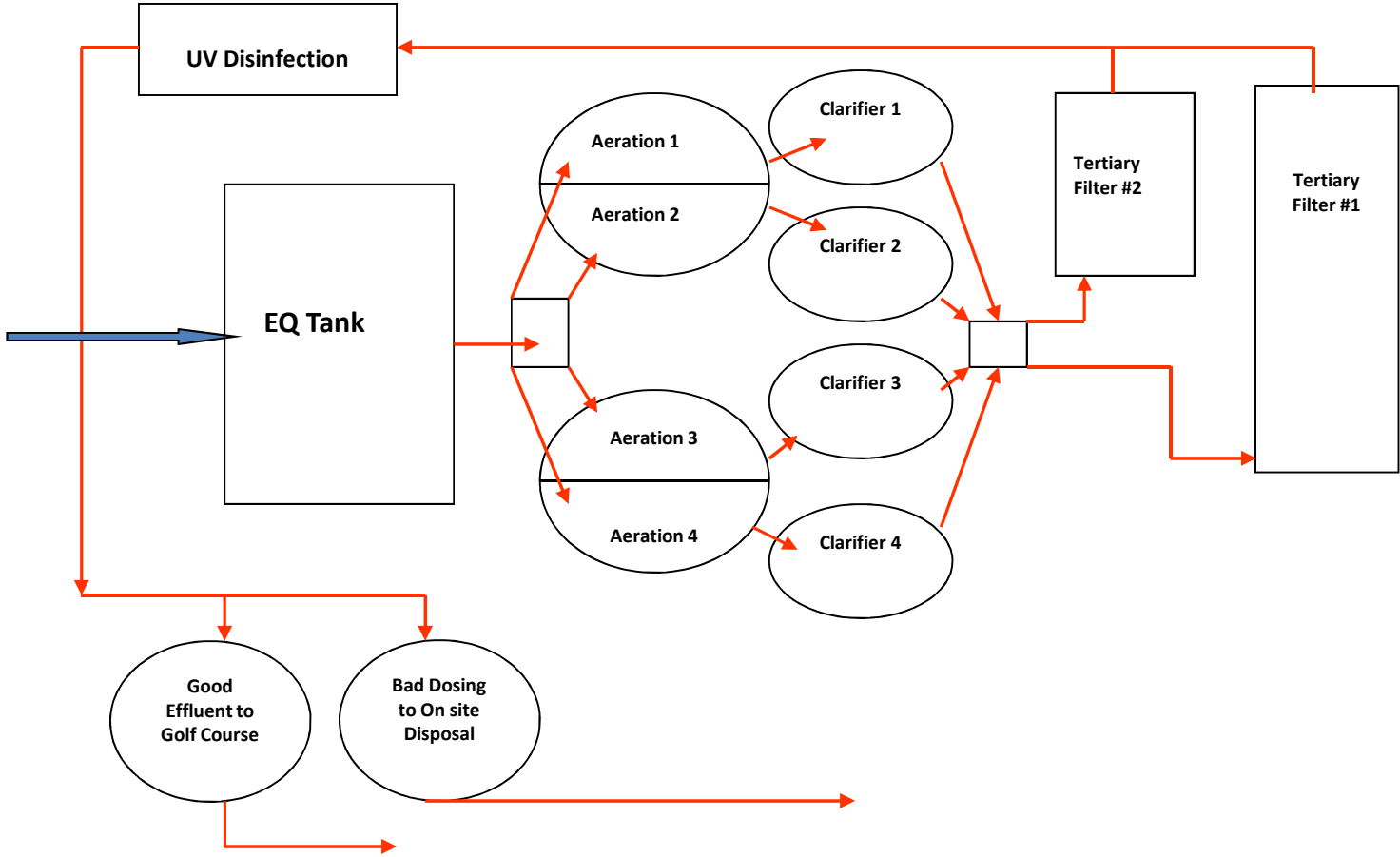
Site ID	Facility Type	Type of Reuse	Treatment Systems	Scale of reuse
A PINC	Resort; golf course community with two hotels and small commercial; 900 customers	Surface irrigation of golf course & common grounds; water features	Activated sludge and tertiary filtration w/UV	Large-scale multi-subdivision development; cluster
B KDNC	Resort; residential and commercial resort community; 475 customers	Surface irrigation of common grounds; water features	Extended aeration and tertiary filtration w/UV	Large-scale subdivision & commercial district; cluster
C GWNC	Resort; retirement community; small; “residential” condo	Surface irrigation at individual homesites & common areas	WWTP w/Cl.	Small-scale condominium complex; cluster
D GSNC	Seasonal; school complex; high school and middle school	Subsurface drip irrigation of ball fields (football, soccer, baseball)	Constructed wetland and tidal wetland w/Cl and UV	Small-scale , on-site; “wastewater mining”; advanced on-site backup system
E KETX	Very small cluster system	Surface irrigation system with pop-up sprayers	Suspended growth ATU w/Cl	Very small-scale cluster system; on-site
F VNYC	High-rise family residential bldg; “residential”	Toilet flushing in high-rise, chiller makeup waters and irrigation	MBR w/ UV and Ozonation	Medium-scale on-site; “sewer mining”; sewer backup
G SNYC	High-rise family residential ,with commercial aspects	Toilet flushing in high-rise, chiller makeup waters and irrigation	MBR w/ UV and Ozonation	Medium-scale on-site; “sewer mining”; sewer backup

Site A WWTP

- A privately held Public Utility
 - 900 customers
- Design flow = 600,000 gpd
- Avg. daily flow = 350,000 gpd
- Non Compliant effluent – less than 1% of time
- Activated sludge followed by tertiary treatment
- UV disinfection

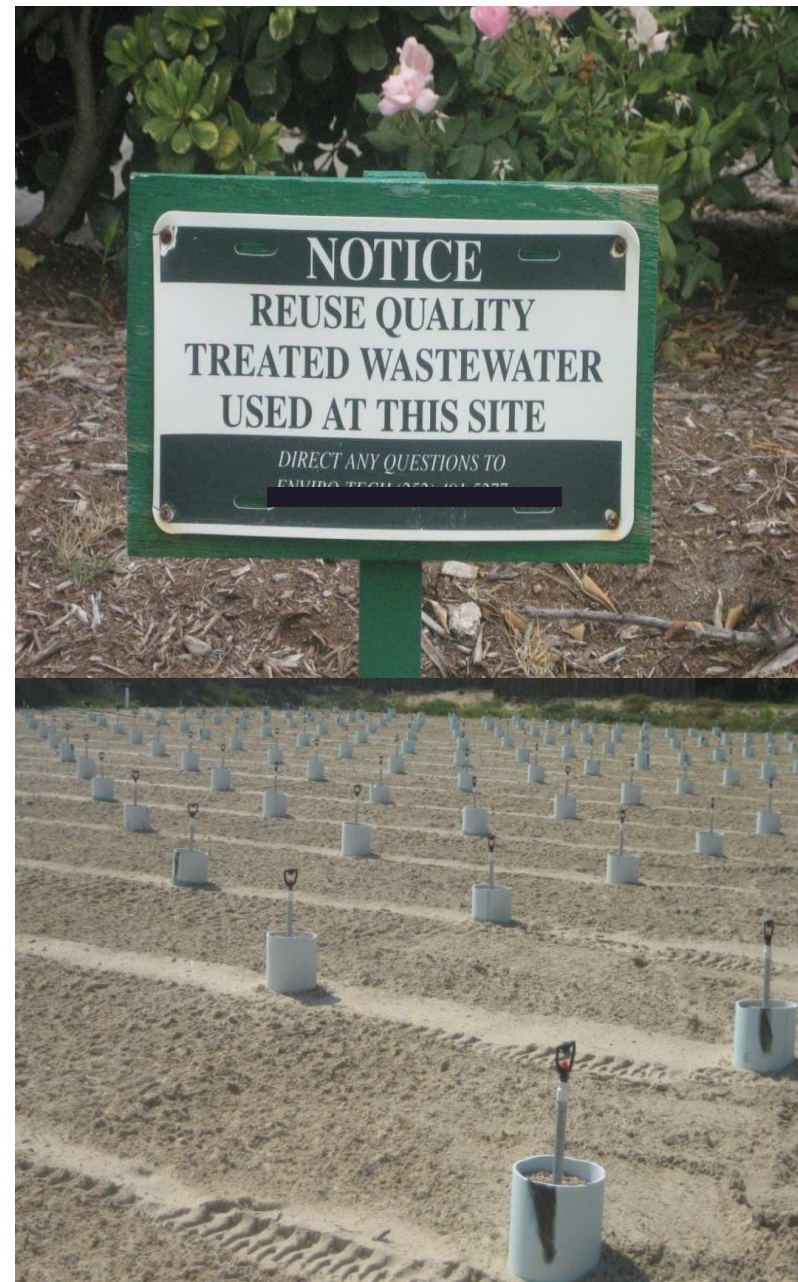


Site A - process flow diagram

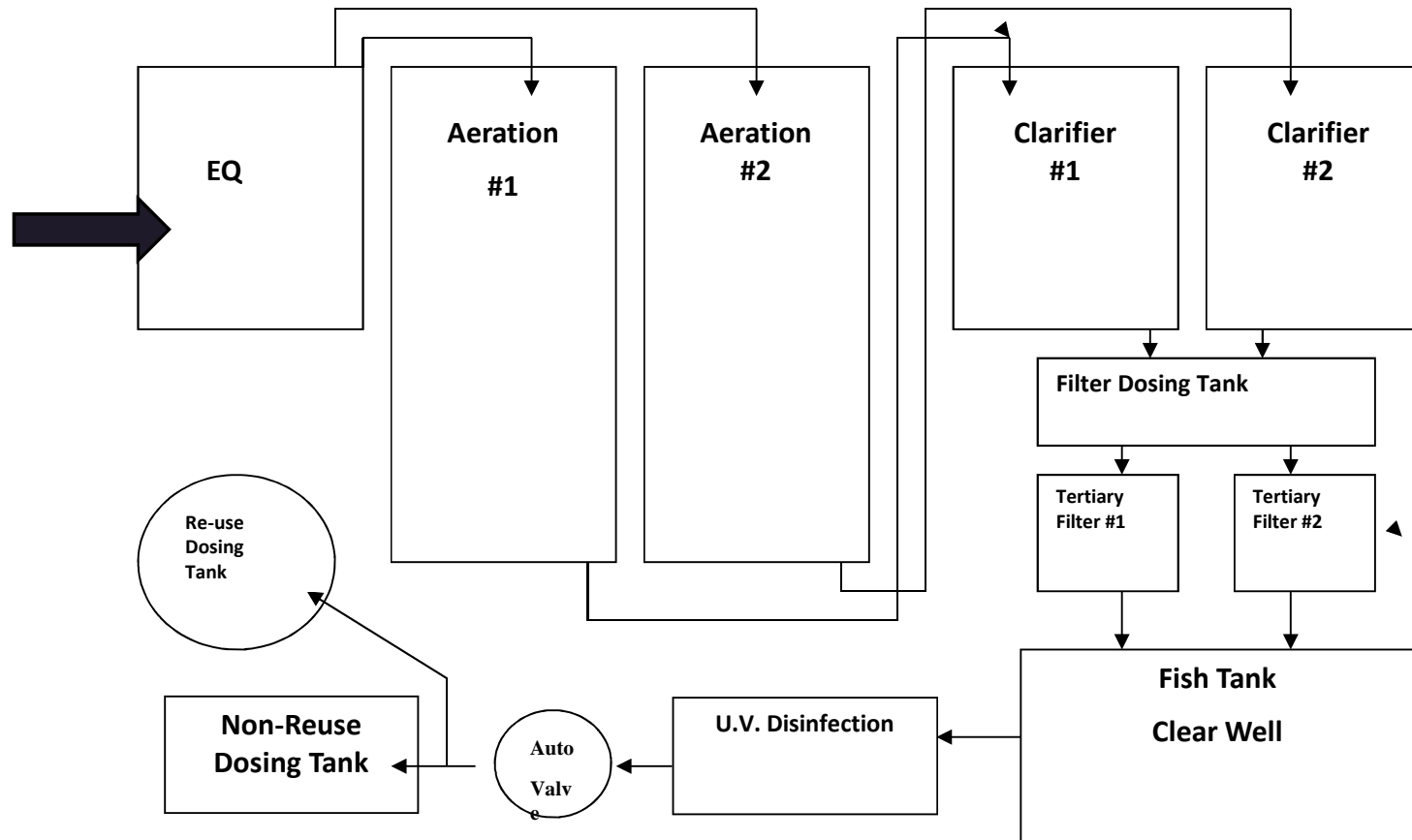


Site B WWTP

- Serves about 475 customers
- Design flow: 500,000 gpd
- Actual flow: 20,000 to 25,000 gpd
- Extended Aeration process
- UV disinfection



Process diagram for site B WWTP plant



Site

- A privately held Public Utility serves about 41 patio houses
- Total design flow = 36,000 gpd
- Activated sludge followed by clarifier and then sand filter with chlorine disinfection
- Chlorine dosing = 0.5ppm

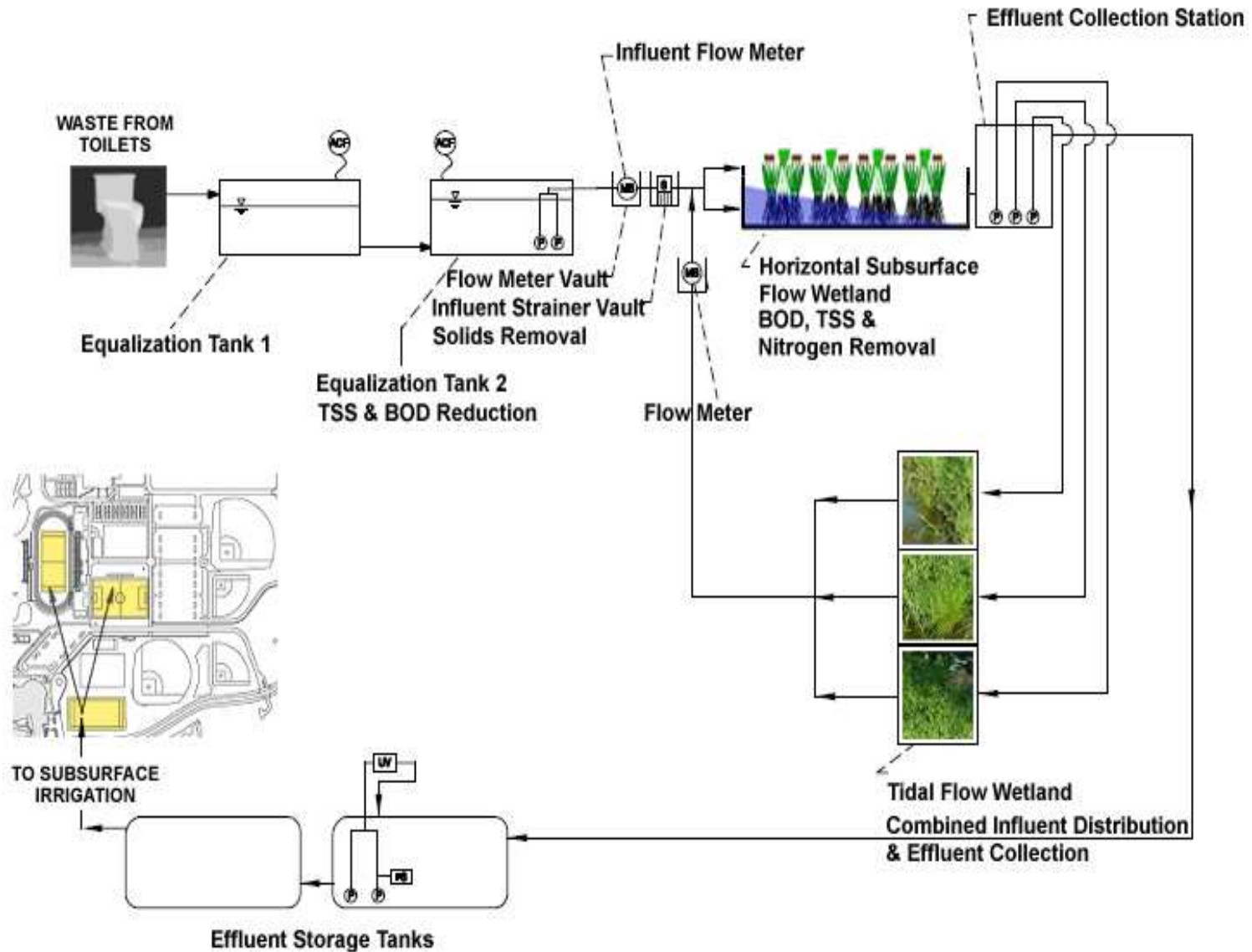


Site D

- Wastewater flow – 25,000 gpd
- Horizontal flow wetland nitrification basin with gravel media and aquatic plants
- Three tidal marsh upflow wetland denitrification biofilters with medium and coarse sand media and aquatic plants
- Storage, disinfection, and pumping to drip irrigate athletic fields
 - Stadium football field
 - Football field
 - soccer field



Site D - Process flow diagram



Site E

- Design flow = 770 gpd
- Actual flow = 600 gpd
- Suspended growth ATU with chlorine disinfection
- All of the reclaimed water is used in the spray field



Site F

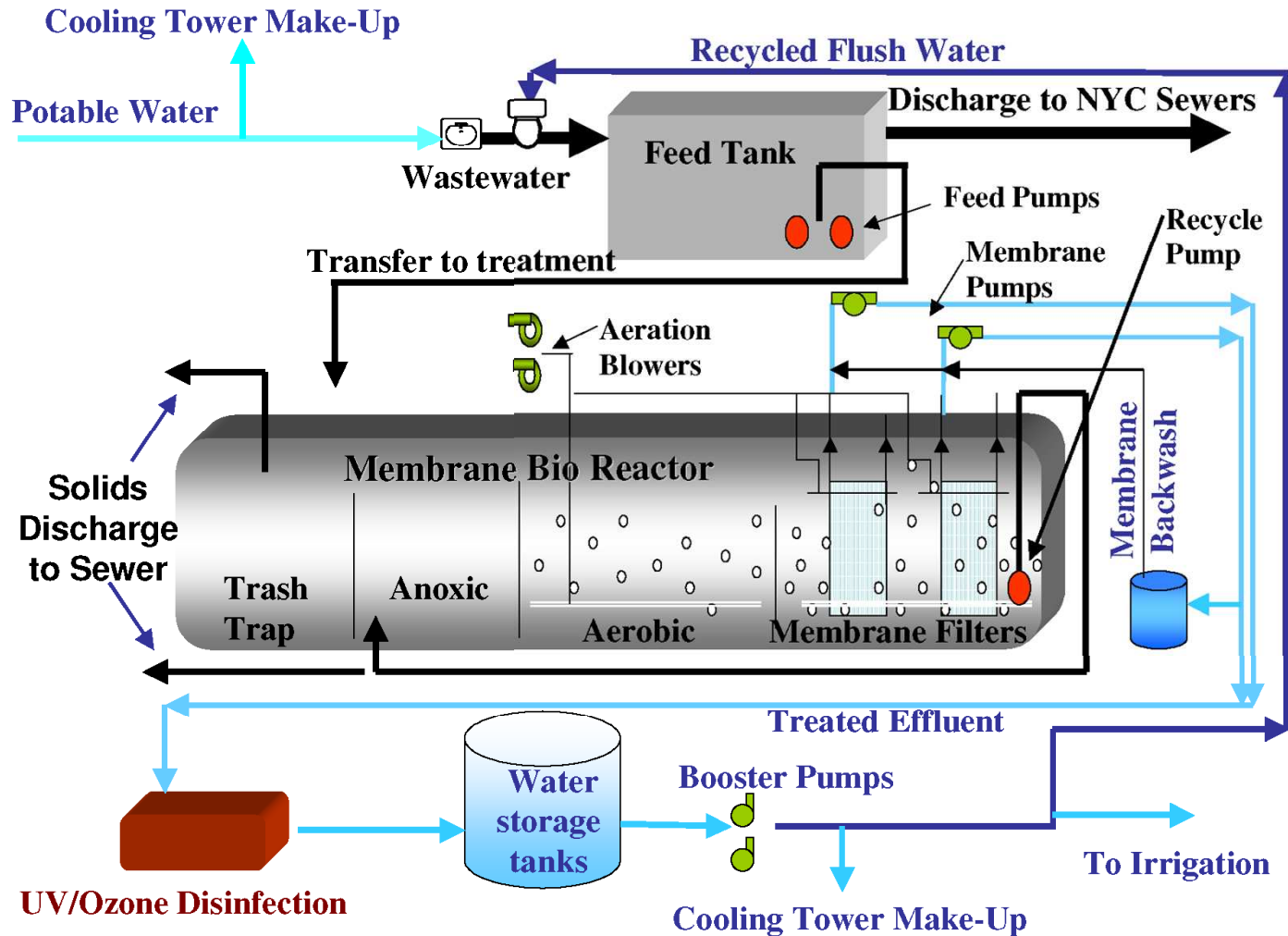


- 251 Condominiums (35 stories)
- 30,000 gpd WW treatment plant
- Platinum Certification LEEDTM
- 48% reduction in water use
- > 50% reduction in wastewater discharge
- MBRs – Ultra-filter
- UV and Ozone

Source: Edward A. Clerico, P.E., President Alliance Environmental LLC

Site F - Process flow diagram

Schematic Flow Diagram



Site G

- 293 units
- 25,000 GPD WW treatment plant
- LEEDTM Gold Certification
- 48% reduction in water use
- 56% reduction in wastewater discharge



Source: Edward A. Clerico, P.E., President Alliance Environmental LLC

Site G - Process flow diagram

