


# Decentralized and Distributed Wastewater Reuse Applications

Victor D'Amato, PE




# Presentation Outline

- ***Introduction***
    - Distributed Systems
    - Sustainability
    - Why Distributed Systems?
  - **Technological approaches**
    - Technology options
    - Integrated resource management and resource-efficient design
  - **Decision-support tools**
    - Green building rating systems and sustainability metrics
    - Multi-criteria decision models
    - Full cost accounting
  - **Applications – thumbnail case studies**
    - Site scale examples
    - Neighborhood scale examples
    - Utility scale examples
  - **Ongoing Research Projects**
    - WERF When to Consider Distributed Systems
    - EPRI Case Studies for New Water Infrastructure Paradigm
- 

# Introduction

**Basic water quality and infrastructure needs are not adequately addressed by the current water management paradigm**


- 45 percent of assessed rivers and streams, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarine square miles listed as pollutant-impaired
  - Aging infrastructure; POTW needs = \$203B (2004)
  - Supply issues increasingly dire
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# Introduction


**Alternative infrastructure approaches considered in cases where traditional centralized models are grossly impractical and uneconomical**

- Funding mechanisms and regulatory programs evolved by targeting gross surface water pollution
- Industrial specialization model of centralized infrastructure approaches to water management
- Critical paths for successfully implementing centralized systems are understood and the “default”

# 21<sup>st</sup> Century Challenges

- Water supply vulnerability
  - Climate change
  - Increased drought frequency and intensity
  - Ecosystem health and natural service deterioration
  - Water quality impairment
  - Aging infrastructure
  - Increasing energy costs
  - Interdependency between energy generation and water use
- 

# 21<sup>st</sup> Century Solutions

- Watershed management
  - Comprehensive planning
  - Distributed systems
  - Ecological restoration
  - Green building
  - Smart, clean and green technologies
- 

# Distributed Systems

## Managed Distributed Infrastructure

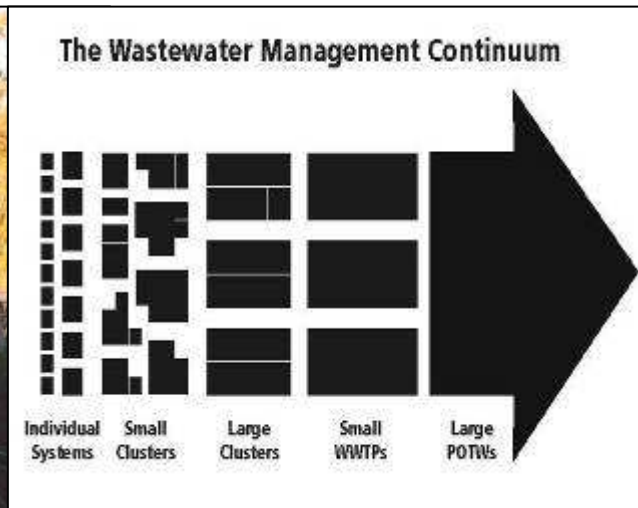
Integrated infrastructure planning, design, management using systems at various scales, based on an equitable, situation-specific consideration of system appropriateness and sustainability

- For wastewater: onsite to cluster to centralized
- For stormwater: low-impact design, BMPs
- Centralized oversight generally preferred
- Part of a green and gray infrastructure approach

# Distributed Systems

## Appropriate system scales: distributed

- Onsite
- Cluster
- Regional/satellite
- Central

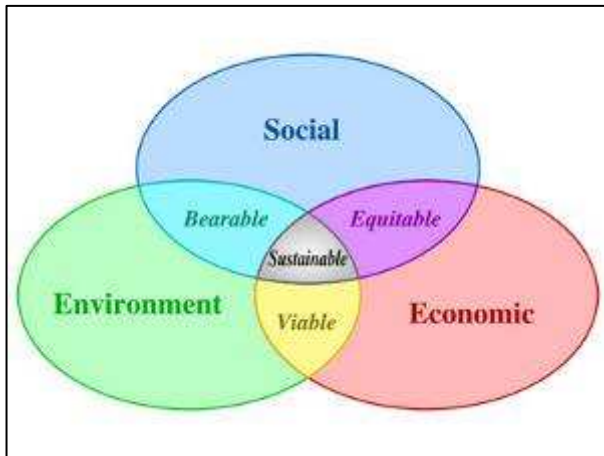


# Distributed Systems

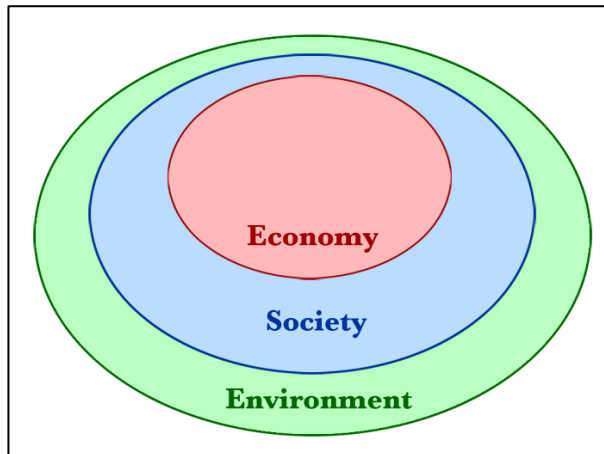
- Examples of distributed infrastructure being used within centralized services areas currently exist
  - Gravity sewer or lift station within a traditional collection system
  - Industrial pretreatment systems
  - Satellite facilities for localized reuse
  - Dual plumbing for reuse water
- Additional progressive examples where distributed systems are being intentionally integrated



# Sustainability



(Adams 2006)



(Ott, 2004)

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

- United Nation’s World Commission on Environment and Development (the Brundtland Commission)

Three pillars or a “triple bottom line” of environmental, societal, and economic considerations

# Sustainability

- Sustainability can also be viewed from more of a risk management perspective (adaption or prevention)
- Water infrastructure has triple bottom line implications

	<b>Change (Risk)</b>	<b>Solution (Management)</b>
Environmental	Climate change Ecosystem collapse Water supply disruption Resource scarcity	Reduced emissions/climate stabilization Ecosystem restoration Water supply augmentation Resource recycling
Economic	Rising material/energy costs Food supply disruption Infrastructure failure Natural disaster Reduced access to financing Productivity decline Economic recession/depression	Passive, efficient, adaptable systems Local resource reuse and agriculture Distributed infrastructure Resilient, robust systems Sustainable asset management Reliance on human capital Cleantech economic growth
Social	Declining standard of living Social unrest Violence/war	Healthy, enjoyable living, work, recreational space Social connectedness Prevention, preparedness for disruption

# Sustainable Water Infrastructure

## Environmental

- Carbon neutral or positive
- Hydrologically neutral or restorative
- Ecologically neutral or restorative
- Nutrient (and other reusable/recyclable waste resource materials) neutral
- Neutral or positive air quality benefits

## Social

- Provides clean and abundant water supply
- Supports safe and secure food supply
- Supports clean and stable energy supply
- Supports healthy and enjoyable living, working, recreational space
- Supports and enhances social connectedness

## Economic

- Promotes economic opportunity across socioeconomic class
  - Promotes local “cleantech” industry growth
  - Minimal debt and associated servicing – low life cycle costs
  - Lower external and imbedded costs
  - Robust in the face of economic and/or social disruption
- 

# A New Paradigm

## **Baltimore Charter for Sustainable Water Systems**

- “A commitment to design new water systems that mimic and work with nature. These systems will both protect public health and safety and will restore natural and human landscapes. “

<http://sustainablewaterforum.org/baltimore.html>

## **National Academy of Engineering**

- Grand Challenges:
  - *Provide access to clean water*
  - *Manage the nitrogen cycle*
  - *Restore and improve urban infrastructure*
  - “small-scale technologies for local water purification may be even more effective for personal needs”

## **Water Environment Research Foundation**


- When to Consider Distributed Systems in an Urban and Suburban Context
- Using Rainwater to Grow Livable Communities

<http://www.werf.org/livablecommunities/>




# Why Distributed Systems?

## **Drivers for and benefits of distributed management**

- Infrastructure funding
  - Treatment system efficiencies
  - Integrated water/watershed management
  - Sustainable design/green building
- 


# Why Distributed Systems?

## Infrastructure funding

- Centralized infrastructure projects defined by large sunk costs that usually require financing
  - Debt service associated with conventional projects can be crippling, particularly in the event of economic downturn (less tax revenue, fewer users)
  - “Pay as you go/grow” infrastructure can be financed by developers or communities incrementally
  - More dispersed/diversified infrastructure investments have lower risk of catastrophic failure
  - Full costs, including externalities, are favorable.
  - Emerging service delivery mechanisms, funding approaches, business opportunities
- 

# Why Distributed Systems?

## Efficiency

- Treatment close to the source requires less energy for conveyance.
  - Urban reuse retrofits are non-disruptive.
  - Relatively passive, eco-mimicking system designs can be utilized effectively
  - Decentralized systems often rely on robust and stable attached growth or hybrid processes
  - Collection systems use smaller pipes with shallower burial depths
  - Security against catastrophic failure
- 

# Why Distributed Systems?


## **Integrated water management**

- Distributed approaches facilitate integrated stormwater and wastewater reuse
- Address scarcity issues through alternative sources of supply
- Land application promotes hydrologic and ecological restoration
- Multiple watershed benefits are achievable.




# Why Distributed Systems?

## **Sustainable design/green building**

- Multiple LEED points related to water conservation are available
  - System multifunctionality can yield diverse benefits resulting from integration into building and site designs
  - Resource recovery potential within facilities
  - Water reuse/conservation
  - Microclimate energy and comfort benefits
- 

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    - Green building rating systems and sustainability metrics
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# Wastewater Technology Options

## Collection

- Small-diameter gravity, pressure, vacuum sewers
- Septic tank effluent gravity (STEG)
- Septic tank effluent pump (STEP)
- Grinder pump


## Treatment

- Primary – grease trap, septic tank
- Secondary – suspended, attached, hybrid
- Tertiary – disinfection, BNR, post-filtration, etc.

## Disposition

- Discharge
- Land (surface/subsurface) dispersal
- Reuse/resource recovery

## Resource Recovery Technologies

- Anaerobic digestion
  - Composting
  - Rainwater harvesting (rain barrels, cisterns)
  - Green stormwater infrastructure
- 

# Technology Options

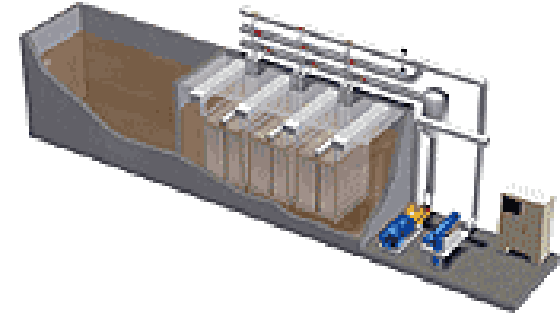
## **Consider range of treatment approaches**

- Base on resource management and infrastructure objectives
- Start with design goals and objectives and work backward for selection and application of technology
- Simple, low-tech and more mechanical, higher tech systems both capable of reliably producing reuse quality water



# Technology Options

- Mechanical systems may be more appropriate in highly urbanized areas requiring small system footprints



- Natural systems can be integrated into buildings and public spaces to serve multiple functions



# Technology Options



*(courtesy Foster + Partners)*

## Informed technology designs

- Bio-mimicry
- Eco-mimicry
- Anthro-mimicry



*(courtesy Texas Parks and Wildlife)*




*(courtesy Academy of Natural Sciences)*

# Integrated Resource Management

***“Coordinated development and management of water, land, and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”***

- A systemic approach: closing the loop on all resource cycles: water, nutrients, carbon/energy, metals, etc,
- For IWRM, consider water system holistically, rather than separately as specialized elements (e.g., stormwater vs. wastewater vs. aquatic ecosystems) with limited interrelationships

# Integrated Resource Management

- Perform mass balance across appropriate system boundaries to optimize design for resource recovery rather than dispersal
  - Consider and balance all elements of the system
    - **Water**
      - Natural sources (surface, ground, precipitation)
      - Produced/processed sources (waste, storm, potable)
      - Needs (drinking, cooking, process, irrigation, aquatic ecosystems)
        - Human consumption only accounts for ~20% of water usage
    - Carbon/Energy
    - Nutrients
    - Metals
    - Thermal energy, gravitational energy
- 

# Integrated Resource Management

## Community-supported educational farm

- Inventory all resource streams
- Develop process flow schematics and designs
- Identify and plan for recovered product uses
- Working with state to fit into existing/planned rules

## Integrated agriculture/aquaculture models




# Resource Efficient Design

## Resource conservation and source separation


- Mixing waste with clean/potable water
  - Increases the volume of contaminated media to be treated
  - Fouls a resource that likely required effort and energy to purify in the first place
- More efficient:
  - Conserve or control at source
  - Reclaim resources from waste sources that are not co-mingled



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# Green Building Ratings


- Green building movement is driving building- or site-scale wastewater reclamation and reuse systems
  - US GBC offers up to five Leadership in Energy and Environmental Design (LEED) “Water Efficiency” credits
    - Two for reducing potable water use for irrigation
    - One for advanced onsite wastewater treatment
    - Two for reducing potable water use inside a building
    - Two additional LEED points are provided as “Sustainable Sites” credits related to stormwater quantity and quality management
- 

# Green Building Ratings

## **Other Green Building Rating Systems**

- Sustainable Sites (ASLA, et al.)
  - Green Globes (CSA, et al.)
  - Model Green Home Building Guidelines (NAHB)
  - Green Matrix (Ratcliff Architects)
- 

# Sustainability Metrics

- LEED and other rating systems help drive water conservation and localized (but perhaps not watershed-scale) water resource improvements
  - Other *metrics* for sustainability including water, carbon, ecosystem, and community footprinting are emerging
  - Various communities have implemented sustainability indicator projects
  - Need for broader scale sustainability metrics focused on resource management and associated infrastructure
- 


# Decision Support

- Infrastructure choices historically made using limited amount of information to inform decision-making
- Capital improvement planning typically only considers study, design, permitting, capital and recurring costs
- Techniques can be used to factor externalities into infrastructure decision making, yielding a more equitable and robust comparison of alternatives



# Decision Support

## **Multi-Criteria Decision Analysis (MCDA)** **Multi-Criteria Decision Making (MCDM)**

- Supports making numerous and conflicting evaluations
  - Aims to expose conflicts and derive a way to come to a compromise using a transparent process
  - Costs may be one decision-making criterion
  - Other community-specific criteria could also be considered and assigned relative value or weighting in the analytical model
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# Decision Support

## WERF Decentralized Wastewater Stakeholder Decision Model

Step 1: Objectives and Their Importance

Reset

Results

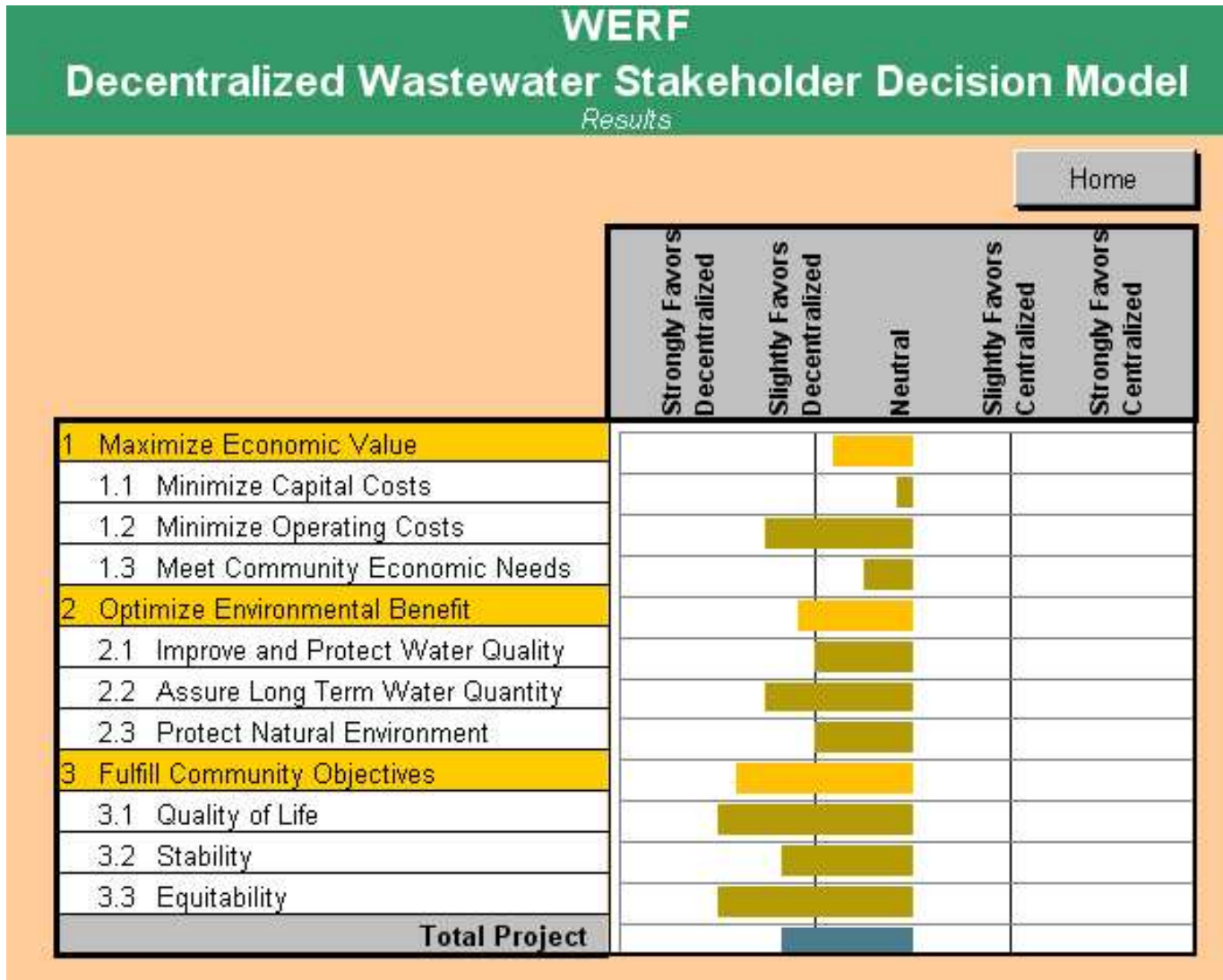
Next Step ==>

Objectives		Rate Importance (0 to 5)	Weights	
<b>1. Maximize Economic Value</b>				<b>30%</b>
1.1	Minimize Capital Costs	4	10.00%	
1.2	Minimize Operating Costs	5	12.50%	
1.3	Meet Community Economic Needs	3	7.50%	
<b>2. Optimize Environmental Benefit</b>				<b>38%</b>
2.1	Improve and Protect Water Quality	5	12.50%	
2.2	Assure Long Term Water Quantity	5	12.50%	
2.3	Protect Natural Environment	5	12.50%	
<b>3. Fulfill Community Objectives</b>				<b>33%</b>
3.1	Quality of Life	5	12.50%	
3.2	Stability	4	10.00%	
3.3	Equitability	4	10.00%	
<b>Total Project</b>				<b>100.00%</b>

# Decision Support


WERF							
Decentralized Wastewater Stakeholder Decision Model							
<a href="#">&lt;== Back</a>		<i>Step 2: Value the Attributes of Each Objective (Page 1 of 3)</i>			<a href="#">Home</a>		
<a href="#">Next == &gt;</a>							
1.1 Minimize Capital Costs		Strongly Favors	Slightly Favors	Neutral	Slightly Favors	Strongly Favors	Not Applicable
<p>Capital costs are important from the perspective of initial funding mechanisms and they are a factor in the overall cost of the service. Lower capital cost help make the initial investment more affordable and with less overall impact to community debt burden.</p>							
<p><b>1.1.1 Planning and Design</b> – As a percentage of capital costs, planning and design costs tend to favor larger centralized projects unless the larger capital projects are in areas that have a lot of conflicts with other utilities, property right-of-ways, existing improvements or sensitive environmental areas or in cases where the expansion of the centralized system requires complex system configurations due to inadequate available land area.</p>		C	L	C	F	C	*
<p><b>1.1.2 Land</b> – Land costs can be a very significant portion of capital costs unless the land can serve multiple purposes. Some decentralized approaches can fit within spaces that serve other purposes while allowing these spaces to continue in their original function thereby eliminating the cost of additional land. Examples such as green roofs and on-site treatment systems utilize existing spaces for location of treatment mechanisms.</p>		C	R	C	C	C	*
<p><b>1.1.3 Phasing</b> – Dividing the project into smaller scale phases helps reduce the need to overbuild for future needs and cuts capital costs. Phasing can be one of the most important management tools for controlling and reducing capital costs. Decentralized approaches allow the overall community need to be divided into smaller segments and more appropriately phased to meet shorter term projects.</p>		C	R	C	C	C	*
<p><b>1.1.4 Optimize existing treatment infrastructure</b> – Addressing wastewater treatment needs with small decentralized approaches can stretch the life expectancy and functional benefits of existing centralized treatment systems thereby reducing capital costs overall. Also, in some cases decentralized approaches, often referred to as best management practices, help a community achieve a water quality goal without increasing the performance of the centralized wastewater system, e.g. by controlling pollutant runoff from stormwater by creating vegetated stream buffers and thereby save on expensive upgrades to the centralized treatment system.</p>		C	R	C	C	C	*
<p><b>1.1.5 Optimize existing collection system infrastructure</b> – Expansion or replacement of collection systems, pump stations and transmission mains can be eliminated through decentralized approaches. In many cases, the existing wastewater collection system service area was limited to that which had the greatest need and was most affordable to serve. Expanding collection systems to serve these areas can often be avoided through the use of decentralized alternatives.</p>		C	C	R	C	C	*
<p><b>1.1.6 Financing Alternatives</b> - In many cases, wastewater infrastructure projects of any type can not proceed without first securing a funding mechanism that provides money for studies, planning, design and construction. Accessibility and cost of funding are important factors and traditional government grants and low interest loans made available through the Clean Water Act (State Revolving Fund programs) almost exclusively favored centralized wastewater approaches. Modifications of these programs through the American Recovery and Reconstruction Act (ARRA) funding now provide funding of decentralized alternatives and increased funding levels for green project approaches which often are more readily accomplished with decentralized approaches.</p>		C	C	C	R	C	*

# Decision Support




# Decision Support


## Full Cost Accounting

- Decision-making rooted in cost as primary criterion
  - Assign costs to externalities
    - Value environmental and social secondary impacts
    - Quantify avoided costs associated with alternatives
    - Value natural resource/ecosystem services
  - Market mechanisms or programmatic drivers are useful (e.g., stimulus funding formulae)
- 


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# Distributed System Applications

- Building- or Site-Scale
    - Onsite dispersal or discharge system
    - Green building/sustainable design-driven resource recovery
  - Neighborhood or Community-Scale
    - Managed cluster/community dispersal or discharge
    - Cluster/community reuse
    - Intentional communities featuring innovative resource recovery
  - Centralized Service Area
    - Managed decentralized (multiple systems in management area)
    - Managed distributed
    - Sewer mining and satellite facilities
- 

# Satellite and Sewer Mining Systems

- **Satellite systems** can be thought of as neighborhood scale systems with a primary purpose of reclaiming and reusing treated effluent closer to the source and reuse area. They are often interconnected to a centralized collection system as a backup and/or to discharge residuals.
  - **Sewer mining** projects are those where a sewerline is essentially tapped to provide raw sewage to be treated for localized reclamation and reuse. Again, interconnection to the centralized collection system is typical for backup and residuals management.
- 

# Example Case Studies



- **Site/Building Scale**
  - Jordan Lake Business Park
  - Sidwell Friends School
  - Workplace6
  - Philip Merrill Environmental Center
- **Cluster/Community Scale**
  - Currumbin Ecovillage
  - Rancho de Bosque
- **Distributed Utility Scale**
  - Sydney Water
  - Mobile, Alabama (MAWSS)
  - Loudon County, VA
  - LOTT Alliance

# Jordan Lake Business Center

## IWS System Performance



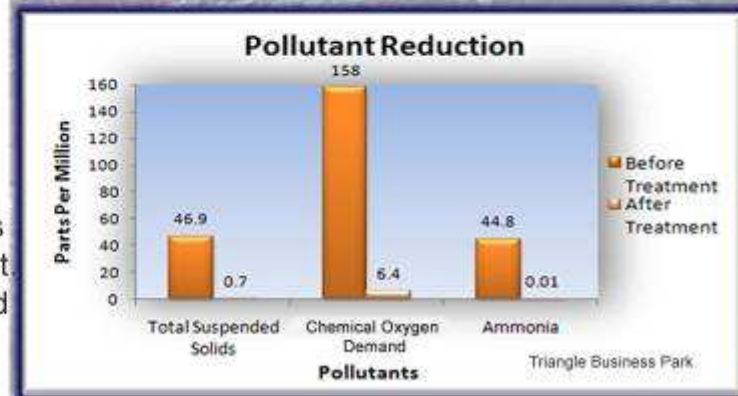
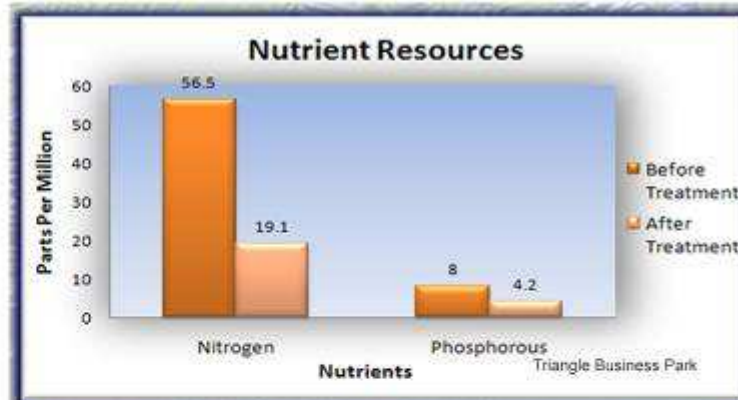
Courtyard Wastewater Treatment System at Triangle Business Park

**Project:** Triangle Business Park

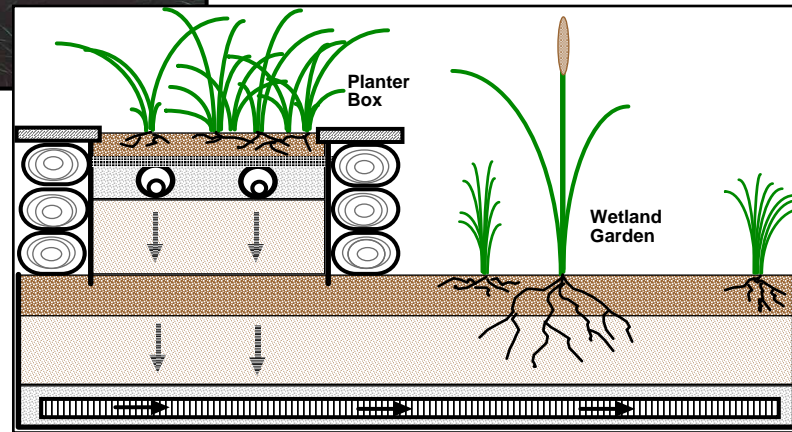
**Description:** A 1200 gallon per day water reclamation and reuse system consisting of raised planter beds and constructed wetlands treatment in an inviting courtyard environment

**System Components:** Vegetated Raised Planters, Subsurface wetland, Irrigation of landscaped areas around building

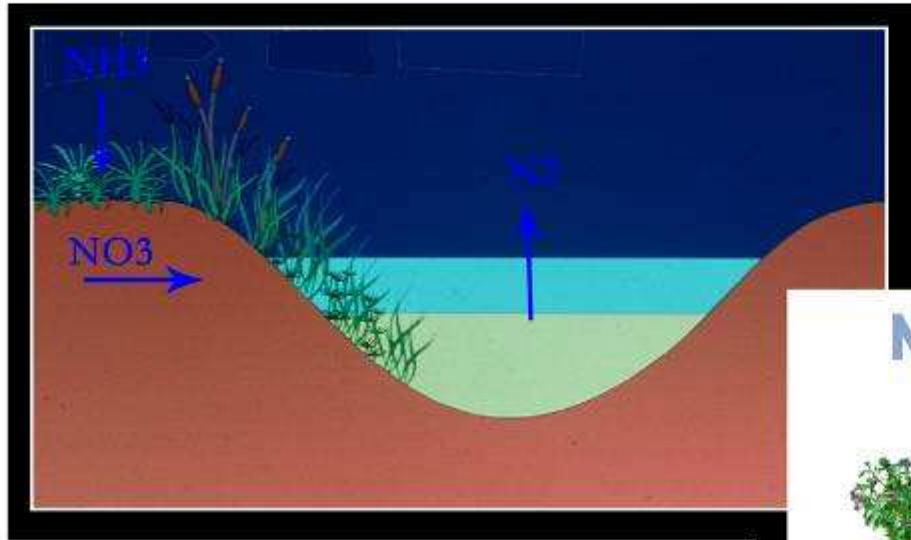
**Constructed:** 1998



# Green Building: Jordan Lake Business Center



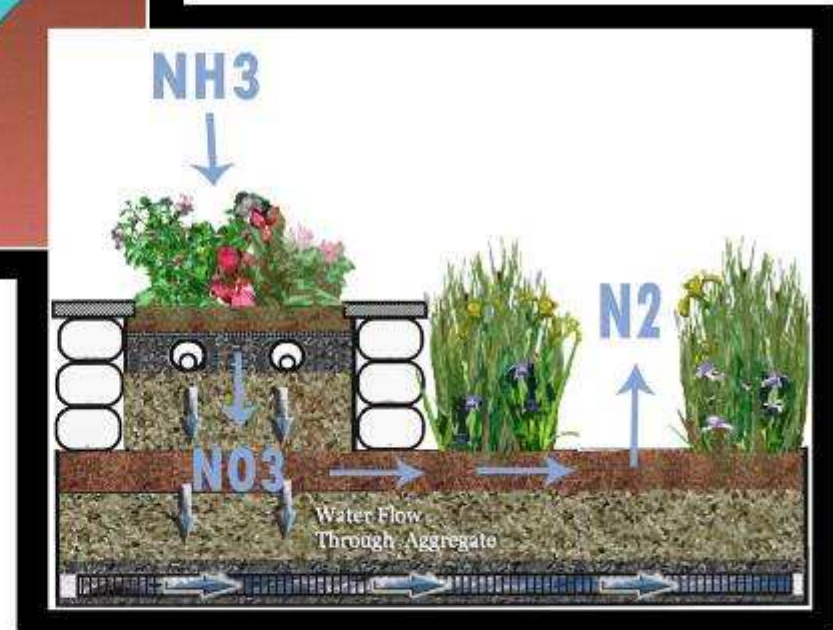
# Nature as a Model



## Designs for Nature by Nature

IWS creates systems that mimic the filtration characteristics of natural ecosystems.

The IWS system process turns Nitrogen into a harmless and odorless gas that can be released into the atmosphere.



**IWS**  
integrated water strategies

1434 Farrington Rd, Suite 600  
Apex, NC 27502  
T: 919-367-8565 F: 919-367-8564

Courtesy of C. Halford House

# Green Building: Jordan Lake Business Park

	Influent	VF Cell	HF Cell	Greenhouse	% Removal
TSS (mg/l)	46.9	4.7	2.7	0.7	98.5
COD (mg/l)	158	21.8	17.0	6.4	95.9
NH <sub>3/4</sub> (mg/l as N)	44.8	10.7	2.5	0.1	99.8
TKN (mg/l as N)	56.4	12.5	3.8	0.3	99.6
NO <sub>3</sub> (mg/l as N)	0.1	12.1	20.4	18.8	--
TN (mg/l as N)	56.5	24.6	24.2	19.1	66.2
TP (mg/l as PO <sub>4</sub> )	8.0	6.0	5.5	4.2	47.5

*Courtesy of Drs. Sarah Liehr (NCSU) and C. Halford House (Integrated Water Strategies, Inc.)*

# Carolina Friends School



Plan View of CFS Upper School Campus and Baseball Field



Section View of Vegetated Sand Filters

## Multi-use Space

**Project:** Carolina Friends School  
**Description:** Fully integrated rain-water/treated wastewater system for the upper school. (Example of courtyard within school environment)  
**Reuse:** Irrigation of baseball field and toilet flush  
**Permitted:** 2008

The Vegetated Sand Filters were designed to fit in with the existing campus and create a landscaped space that people walk through and can sit and chat with a friend.

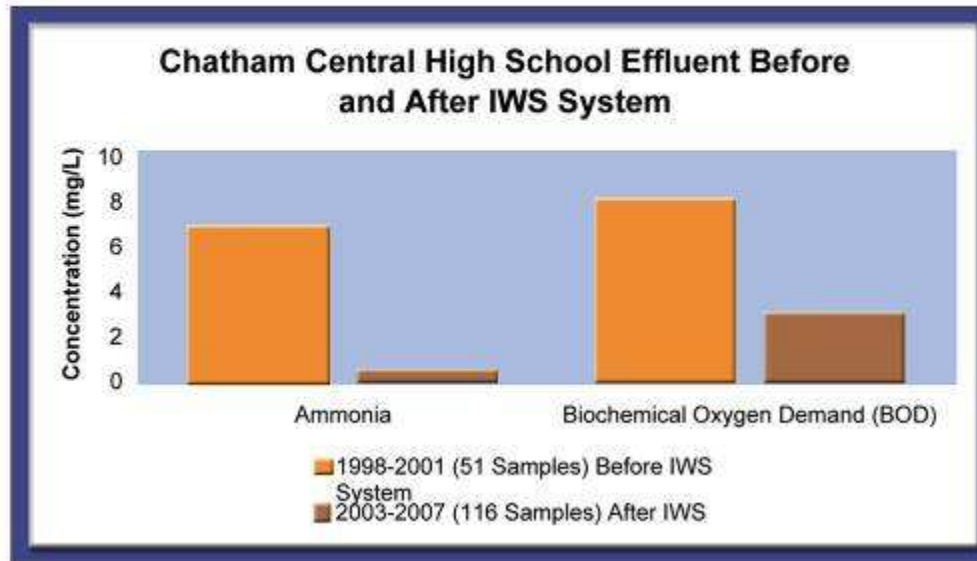


Reuse water can be used to irrigate baseball fields

**iws**  
integrated water strategies  
1434 Farrington Rd, Suite 600  
Apex, NC 27502  
T: 919-367-8565 F: 919-367-8564

Courtesy of C. Halford House

# Central Chatham High School



Vegetated Sand Filter at Chatham Central High School

**Project:** Chatham Central High School

**Description:** Repair of non-compliant 10,000 gallon per day sand filter wastewater treatment system replaced with a Vegetated Sand Filter which provides reuse quality water.


**System Components:** Vegetated Sand Filter

**Constructed:** 2003




Courtesy of C. Halford House

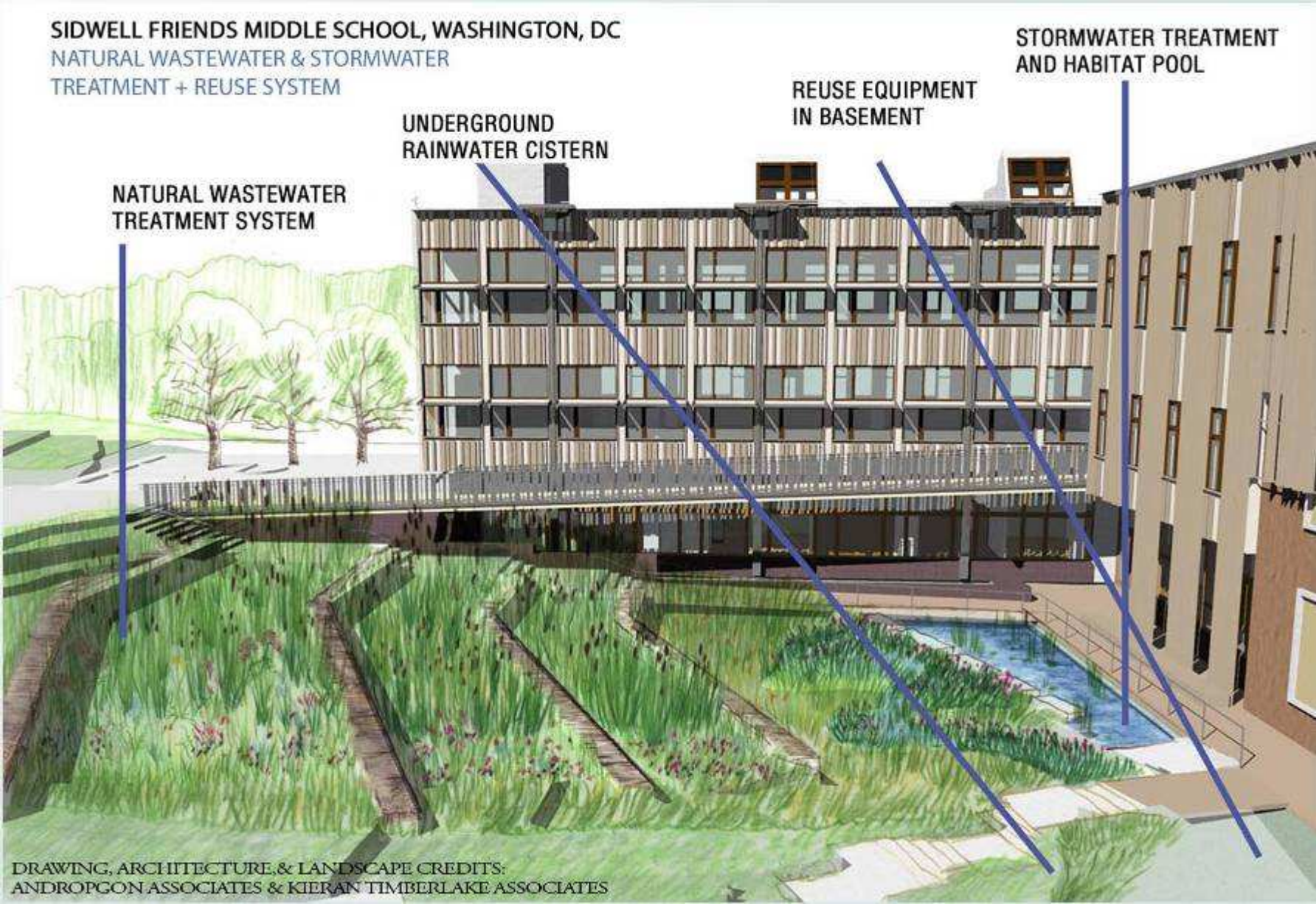
# Sidwell Friends School, Washington, D.C.

- Highly visible project in urban Washington DC
  - LEED Platinum
  - Winner of an American Institute of Architects award for top green building project
  - Design includes four major components that focus on environmental stewardship
    - Water Management
    - Energy Efficiency
    - Building Materials
    - Indoor Air Quality
  - Integrated design team: Kieran Timberlake Associates LLP, Andropogon Associates LTD, JFW Project Management, CVM Engineers, Natural Systems International
- 

# Sidwell Friends School, Washington, D.C.

- Systems for wastewater treatment and reuse are exposed and part of the 'working' landscape of the school's entrance courtyard
  - Wastewater flow of 3,000 gpd
    - Series of terraced constructed wetland cells
    - Recirculating sand filter
    - Trickling filter
    - Reclaimed wastewater is recycled for toilet flushing and cooling towers
  - Stormwater system
    - Rainwater collection
    - Rain gardens with biofiltration
    - Habitat pools for classroom study in the entranceway
- 

# Sidwell Friends School, Washington, D.C.



# Sidwell Friends School, Washington, D.C.



<http://buildingdashboard.com/clients/sidwell/>

# Workplace6, Sydney, Australia

- Showcase waterfront green building
- 6 Stars by Australia's Green Star accreditation system
- 194,000 sf commercial space, Google headquarters
- 5,000 gpd MBR plant with carbon filtration, UV, and chlorine disinfection
  - Receives sewage from the building and an adjacent main sewer
  - Produces high quality recycled water for toilet flushing and park irrigation



# Philip Merrill Environmental Center

- Chesapeake Bay Foundation Headquarters in Annapolis, MD (suburban)
- 32,000 sq. foot Interpretive Center, Commercial office typically occupied by 80 people, 40 hours per person per week
- U.S. Green Building Council LEED-NC, v.1.0--Level: Platinum
- Includes:
  - Photovoltaics
  - Solar hot water
  - Rainwater collection
  - Natural lighting/ventilation
  - Ground-source heating/cooling
  - Bioretention
  - Habitat restoration
  - Composting toilets



# Philip Merrill Environmental Center

- Waterless Clivus composting toilets
  - Reduced water use (only 80 gpd)
  - Reduce nitrogen impacts on bay
  - Compost used as landscape fertilizer



# Example Case Studies



- Site/Building Scale
  - Jordan Lake Business Park
  - Sidwell Friends School
  - Workplace6
  - Philip Merrill Environmental Center
- **Cluster/Community Scale**
  - Currumbin Ecovillage
  - Rancho de Bosque
- Distributed Utility Scale
  - Sydney Water
  - Mobile, Alabama (MAWSS)
  - Loudon County, VA
  - LOTT Alliance

# Clustering for Conservation Design




Source: Arendt, *Conservation Design for Subdivisions*

# Currumbin Ecovillage, Queensland, Australia



- 144 home sites ~7 km from Currumbin Beach on Queensland's Gold Coast, Australia
- Closed-loop water supply system – disconnected from public water system
- 80% preserved as open space
- Food producing streetscaping and landscaping
- Intelligent monitoring system (water, gas, electricity) installed at each home
- Diverse sustainability objectives include “improve biodiversity” and “minimize landform impacts”

# Currumbin Ecovillage, Queensland, Australia

- Each house equipped with rainwater tank(s) that supply all potable water used inside the house
  - Tank overflows and stormwater are collected by use of swale (natural contour) drainage, sometimes staying in drains or discharged into water retention features (ponds) on site
  - Wastewater centrally treated to Class A+ reuse standards. The multi-stage water recycling system uses
    - Textile filters
    - Membrane filtration
    - UV treatment and chlorine disinfection
  - Pumped back to the houses for non-potable uses (more than 80 percent of the water used by households will be recycled water)
    - Toilet-flushing
    - Garden watering
    - Car washing
    - Laundering (when approved by Queensland Health)
    - Fire fighting.
- 

# Rancho de Bosque, Santa Fe, NM



- 23 lot subdivision southeast of Santa Fe, NM
- Development goal was to ensure an attractive landscape in a very arid area
- On-site wastewater treatment and reuse supplies treated effluent for use as irrigation water.
- Each home connected to a small diameter collection system that delivers wastewater to the treatment system.
  - Three cell constructed wetlands
  - Intermittent sand filter
  - Covered storage pond
  - Reuse distribution system uses same trench as the collection system.
- Covenants require use of native plants
- Each home supplied with enough water to irrigate approximately 4,000 square feet

# Example Case Studies



- Site/Building Scale
  - Jordan Lake Business Park
  - Sidwell Friends School
  - Workplace6
  - Philip Merrill Environmental Center
- Cluster/Community Scale
  - Currumbin Ecovillage
  - Rancho de Bosque
- ***Distributed Utility Scale***
  - Sydney Water
  - Mobile, Alabama (MAWSS)
  - Loudon County, VA
  - LOTT Alliance

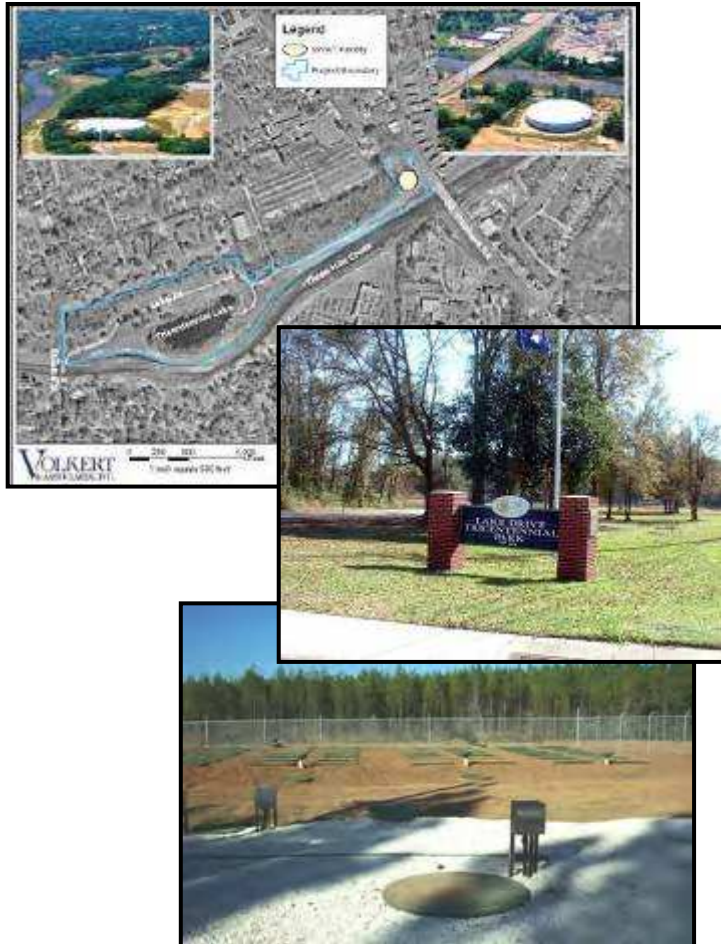
# Sydney Water - Pennant Hills Golf Club

- Privately-driven sewer mining project
- Conveyance costs associated with more traditional centralized reuse systems often render satellite users uneconomic
- MBR treatment system produces 172,000 gallons of high quality water per day
- Treated water is used to irrigate the 22 hectares (55 acres) of greens, tees and fairways.

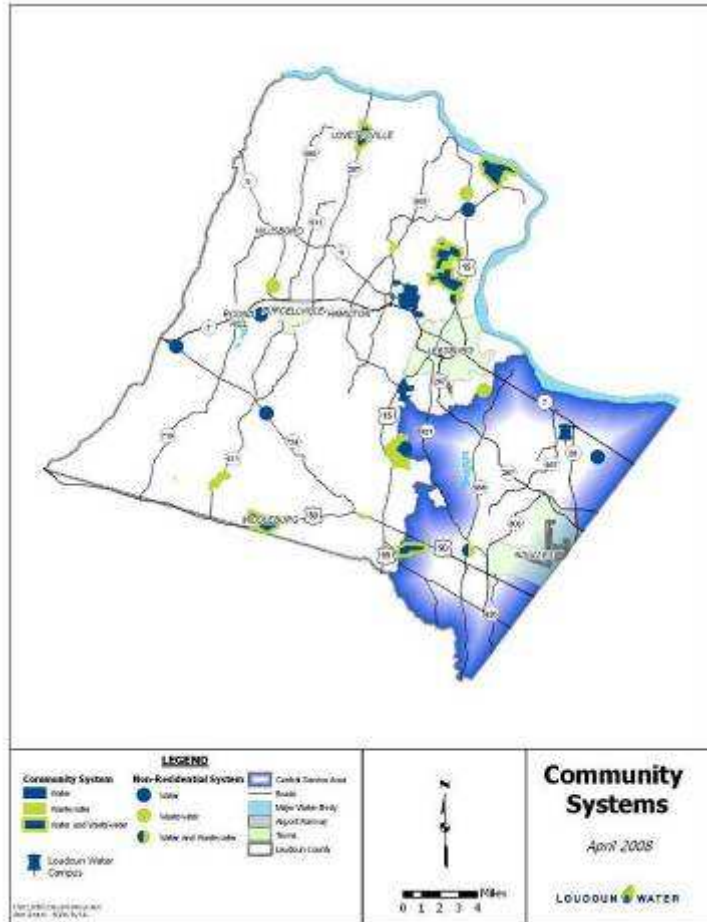


# MAWSS, Mobile, AL

- Service area: 233 mi<sup>2</sup> includes ~1,300 mi. of gravity sewers, ~200 lift stations, ~120 miles of force main
- MAWSS owns and operates (EPA Level V RME) two conventional and at least 12 decentralized wastewater facilities
- On-site treatment/dispersal in Tricentennial Park adjacent to Three Mile Creek
  - Demonstrate use of decentralized facilities within centralized infrastructure (partial EPA funding)
  - Wastewater mined from sewer line and treated using one of three different decentralized systems
  - Treated effluent is distributed through subsurface drip irrigation system to nourish the grass and shrubs in the park



# Loudoun Water, Loudoun County, VA




- Loudoun Water Service Area
  - Water and wastewater utility for Loudoun County, VA (DC suburb/exurb)
  - 56,000 Central System Customers, 1,000 Community Systems Customers
- Loudoun County approach
  - Growth pays for growth
  - Developers design and construct facilities to Loudoun Water standards and at no cost to Loudoun Water
  - Agreement states roles and responsibilities

# Loudoun Water, Loudoun County, VA



- Shared review and approval responsibilities
  - Individ. systems – Local Health review
  - Discharging systems – Loudoun Water & DEQ
  - Cluster systems – Local Health, Loudoun Water, & State Health review
  
- Management highlights
  - RME Level IV (operation) when operating treatment plants for commercial facilities
  - RME Level V (ownership and operation) operating treatment plants for communities
  - Financially self-sustaining via rates and developer paid revenues

# LOTT Alliance, Olympia, WA

- Lacey-Olympia-Tumwater urban area
  - 20-year plan calls for construction of three satellite reclaimed water treatment plants
  - As currently planned, each satellite would initially be built to treat at least 1 mgd, expandable up to 5 mgd
  - Building the satellites in small increments is intended to allow "just-in-time" construction to meet future wastewater treatment needs
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# LOTT Alliance, Olympia, WA

## Budd Inlet Plant



- Advanced secondary treatment with nitrogen removal and UV disinfection.
- Portion is fed to reclamation plant with continuously back-flushing sand filter system and sodium chloride disinfection for distribution system residual.
- Meets Washington State's Class A Reclaimed Water standards
  - Irrigation at the State's Heritage Park and Marathon Park
  - Irrigation at City park facilities along Percival Landing
  - Irrigation, equipment washdown, boat washing, dust suppression, and a constructed pond at the Port of Olympia
  - Irrigation, pumpseals, and cleaning at the Budd Inlet Treatment Plant
  - Cleaning of the pump house and wetwell at LOTT's Capitol Lake Pump Station

# LOTT Alliance, Olympia, WA

## Hawks Prairie Reclaimed Water Satellite




- Martin Way Reclaimed Water Plant – 3.38-acre site on a major commercial thoroughfare with MBR producing 2 MGD class A reuse water, expandable to 5 mgd
- Conveyance Pipelines – 3 miles of purple-coded pipe to transport the reclaimed water from the Plant to the Ponds and Recharge site
- Constructed Wetland Ponds/Groundwater Recharge Basins – 41-acre site located on Hogum Bay Road
  - Class A Reclaimed Water circulates through a series of five constructed wetland ponds, containing about 225,000 wetland plants
  - Ponds provide opportunities for public education, recognition, and acceptance of reclaimed water
  - Four large kiosks provide interpretive displays about reclaimed water, groundwater recharge, and natural features of the site
  - Ponds also serve as an amenity for the surrounding area by offering visitors the opportunity to view and enjoy a wide variety of animals, birds, and aquatic life


# Presentation Outline

- Introduction
    - Distributed Systems
    - Sustainability
    - Why Distributed Systems?
  - Technological approaches
    - Technology options
    - Integrated resource management and resource-efficient design
  - Decision-support tools
    - Green building rating systems and sustainability metrics
    - Multi-criteria decision models
    - Full cost accounting
  - Applications – thumbnail case studies
    - Site scale examples
    - Neighborhood scale examples
    - Utility scale examples
  - ***Ongoing Research Projects***
    - WERF When to Consider Distributed Systems
    - EPRI Case Studies for New Water Infrastructure Paradigm
- 

# When to Consider Distributed Systems in an Urban and Suburban Context

- Identify examples where distributed infrastructure approaches are being used to provide service in areas where traditional approach would be centralized
  - Study critical path details for how these projects were planned and implemented
  - Set forth information using case studies and easily deployable tools that help decision-makers and stakeholders determine whether distributed systems are a viable solution in their community
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# When to Consider Distributed Systems in an Urban and Suburban Context

- Database of case studies
  - Detailed case study summaries
  - Decision-support, planning and implementation tools
  - Guidance compendium (web-based vehicle?)
  - Other targeted communications products (journal articles, white paper, fact sheets, etc.)
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# EPRI Research Projects

## Connection between green building and sustainable water management


- Phase 1 – Stakeholder group/workshops
- Phase 2 – Case studies for new water infrastructure paradigm
  - Facilitated retreat to map out a framework for taking two real communities from their current situations toward a sustainable water infrastructure model
- Phase 3 – Pilot projects on sustainable water management in green building approaches

# Principles of a New Paradigm

- **Value the resource.**

- Recognize all water as water and all water as a resource – no exceptions! Water, stormwater and wastewater are all water.
- Value water – value the entire water cycle.
- Value the resources available in water: nutrients, energy, and carbon.

- **Aspire to higher objectives that spawn better outcomes.**


- Designs should add value and provide multiple benefits.
  - Integrate built environment with natural environment symbiotically.
  - Communities should consider impacts beyond local boundaries (for example, looking at impacts on global climate change, or controlling water quality in the Ohio River to minimize the hypoxic zone in the Gulf of Mexico).
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# Principles of a New Paradigm


- **Smart, Clean and Green**

- “Smart” infrastructure unlocks the complex designs of nature and use information and signaling to achieve efficiencies.
- “Clean” infrastructure captures and uses resources and methods that don’t involve significant externalities in extraction or disposal.
- “Green” infrastructure relies to a much higher degree on vegetation and systems that mimic nature, and in the process begin to restore the natural ecosystem and its wide and deep benefits.

- **Integrate water management decisions with all aspects of community planning and development**

- All community decision making must consider water.
  - Land use relationships to water resource management must be coordinated.
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# Principles of a New Paradigm

- **Recognize true costs and maximize value/benefits.**
    - Design and manage water systems to be all inclusive of all triple bottom line principles.
    - Increase community/system resilience and sustainability.
  - **Adapt and evolve.**
    - Sustainability is never ending.
    - Change is exciting, change is good!
    - Even though the perceived risk of change is high, the riskiest thing is to continue under the current water management paradigm.
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# Principles of a New Paradigm

- **Community shares responsibility, shares risks.**
    - Build and rely on local capital for creative and science-based decision making.
    - The process of informing and engaging stakeholders and the broader community should be transparent and comprehensive.
  - **Locally driven and context sensitive at all scales.**
    - Local actions have implications at every scale.
    - Regulatory environment should be performance based and recognize local context.
  - **Build intellectual infrastructure.**
    - Foster and support research, development and new ideas.
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