Decentralized Wastewater Treatment Systems:

Processes, Design, Management, and Use

Webinar Series Sponsored by the Conservation Technology Information Center, US EPA, and Tetra Tech

Session 6

Integrated Water Resources Management

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Webinar outline

- 21st Century water management (the “new paradigm”)
- Sustainability drivers for and benefits of distributed systems
- Case studies of new applications for decentralized systems
  - Green Buildings and Sustainable Sites
  - Independent Communities
  - Utility Optimization
- Decision support tools
- Additional resources

Evolution of urban water management

- Opportunistic Utilization of Readily Available Water
  - Use of easily accessed surface water and shallow groundwater
  - Use of streets to direct wastewater and stormwater flows
- Engineered Storage and Conveyance
  - Water storage facilities, aqueducts, and drainage facilities
  - Technologies developed in Roman times and earlier are still relied on today
- Addition of Water Treatment Technologies
  - Improved public health and water quality
- Non-Point Source Pollution Control
  - In-progress efforts to manage stormwater runoff
- **Integrated land and water management for total hydrologic and mass balance (*new paradigm*)**
  - Water supply, stormwater, and wastewater managed in a closed loop

(from Brown and Novotny)

21st Century water management


Aerial view of a typical wastewater treatment plant

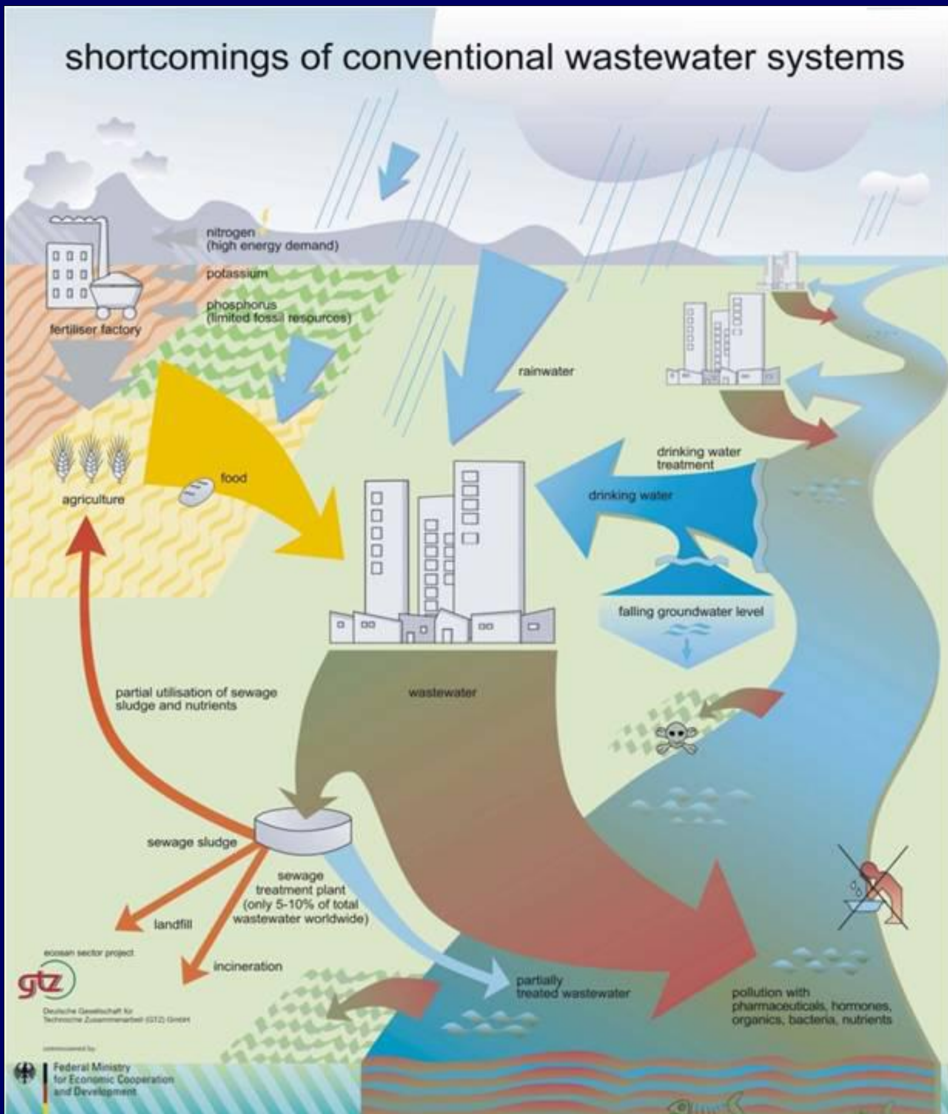
Old paradigm

- *–Highly specialized*
- *–Centralized*
- *–Segregated*
- *–Linear*
- *–Extractive*
- *–Inflexible*

New paradigm

- *–Multifunctional*
- *–Decentralized*
- *–Integrated*
- *–Systemic*
- *–Restorative*
- *–Adaptive*

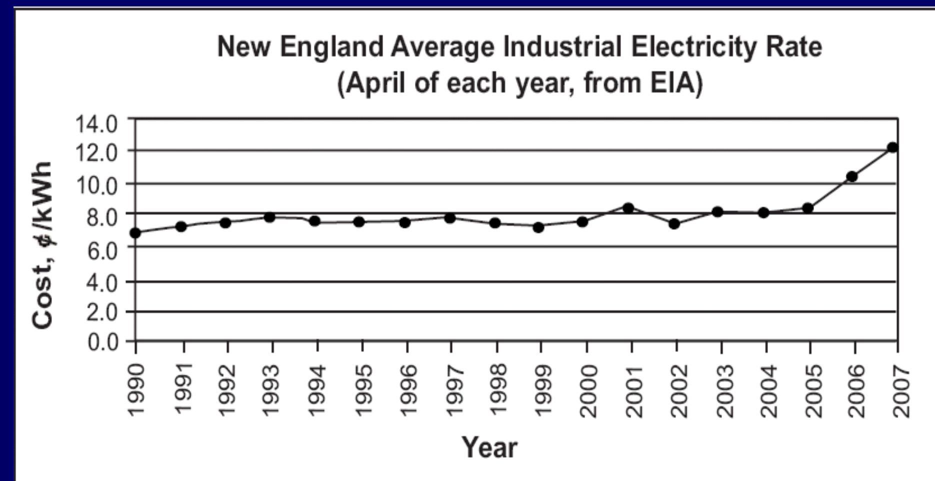
Shortcomings of the old paradigm

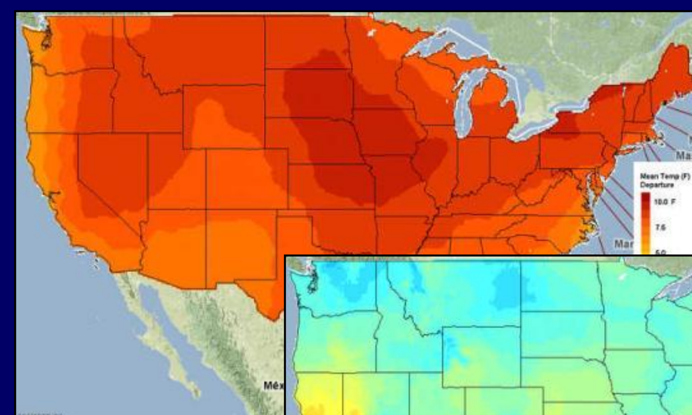


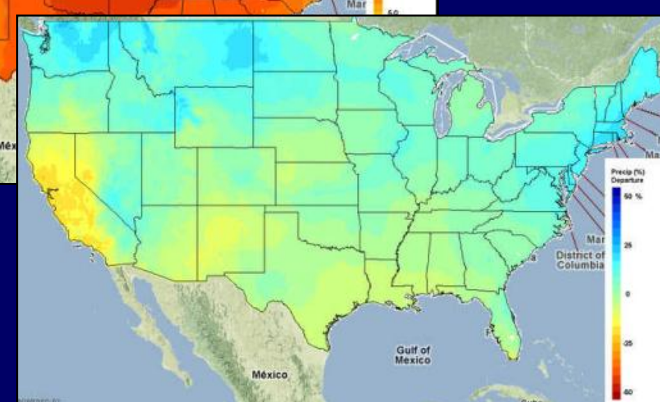
- Water quality impairment
  - 45 percent of rivers and streams
  - 47 percent of lake acres
  - 32 percent of bay and estuarine
- Aging infrastructure
  - Wastewater needs = $203B
  - Gap > $1T
- U.S. water-related energy use
  - >521 million MWh per year
  - ~13% national electricity use
- Supply scarcity and uncertainty

21st Century challenges

- Interdependency between energy generation and water
- Increasing and variable energy costs
- Climate change
- Increased drought frequency and intensity
- Limited fresh water supplies
- Insufficient food supply and unsustainable agriculture model
- Ecosystem health and natural service deterioration
- Water quality impairment
- Infrastructure capital and associated upkeep costs

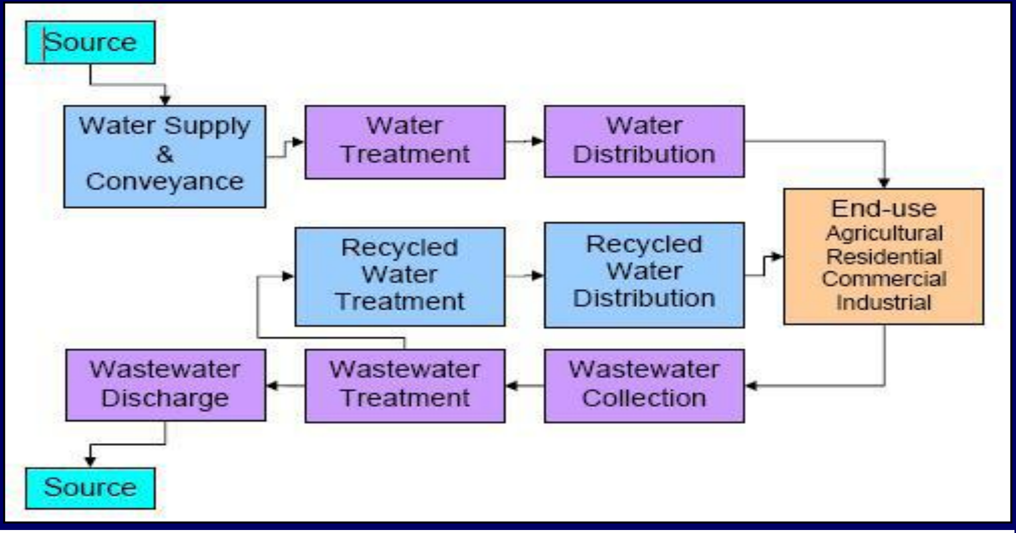






Energy implications of water infrastructure

- Recurring (operational) energy demand
- Embedded (life cycle) energy
- Secondary energy impacts
- Recovered energy
  - Biological
  - Thermal
  - Gravitational



Water Use Cycle Segments	Range of Energy Intensity (kWh/MG)	
	Low	High
Water Supply and Conveyance	0	14,000
Water Treatment	100	16,000
Water Distribution	250	1,200
Wastewater Collection and Treatment	700	4,600
Wastewater Discharge	0	400
Total:	**1,050**	**36,200**

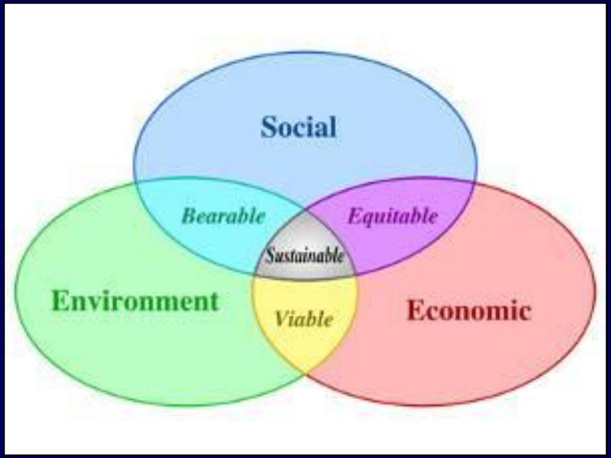
The Carbon Footprint of Water, by Bevan Griffiths-Sattenspiel and Wendy Wilson www.rivernetwork.org

Nutrients as pollutants and resources

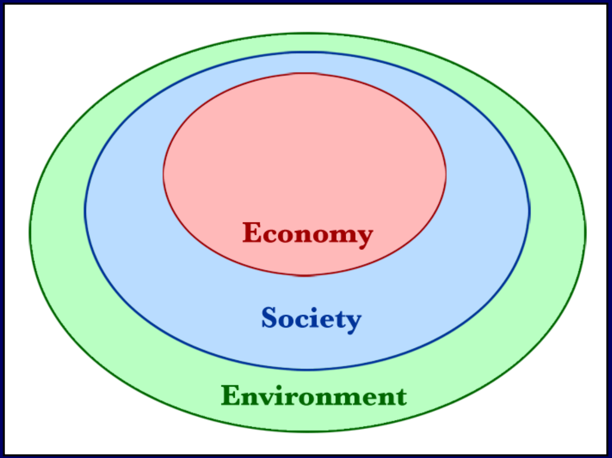
- Phosphorus
  - Finite (expected to be fully exploited in 60-150 years)
  - Agriculturally- and nutritionally-required
  - Largely disposed via wastewater discharges and landfilled sewage sludge
  - Difficult, if not impossible, to recover after dispersal into environment

(Ashbolt and Goodrich 2009)

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)

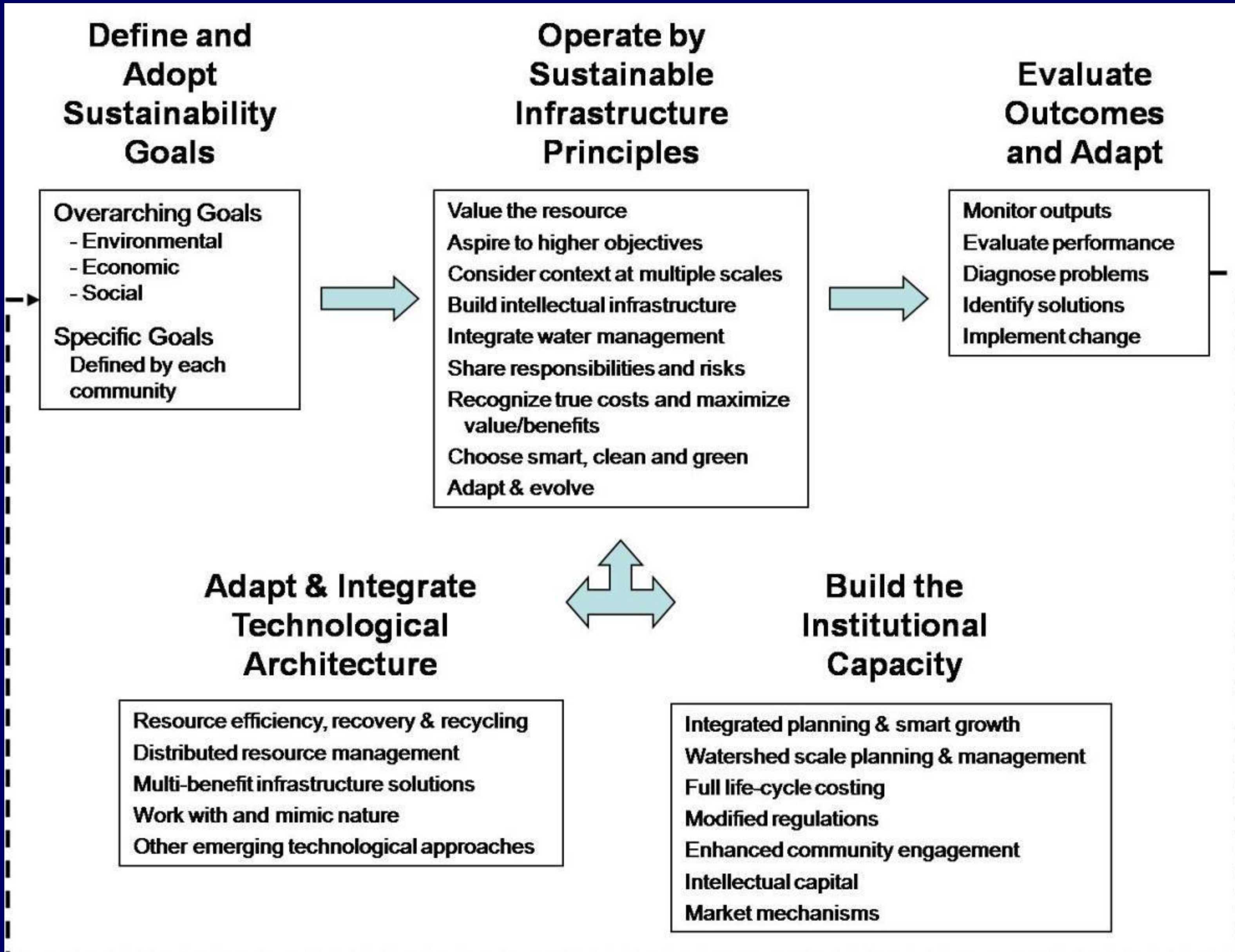
"Sustainability" def. – the capacity to endure

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

New water paradigm – driven by outcomes

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

Key elements of the new water paradigm

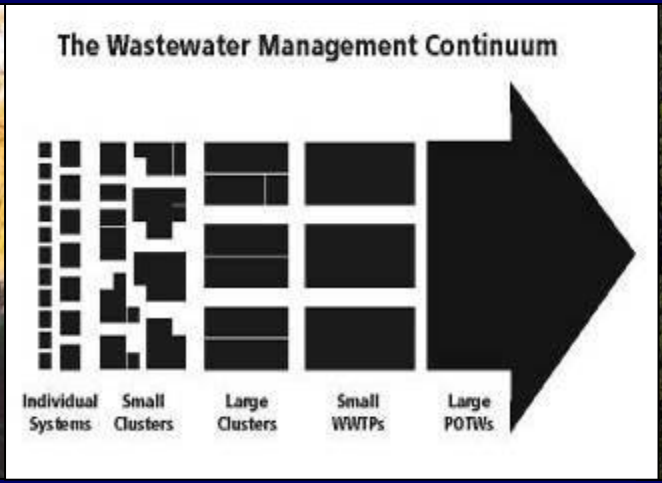


Key differences

Topic	Current Practice	New Paradigm
Water Use	Single use before disposal	Reclaim/reuse water multiple times
Water quality supplied	Treat all water to potable standards	Level of water quality based on intended use
Waste	Dispose of	Recover resources
Stormwater	Convey offsite	Harvest onsite
Infrastructure type	Primarily gray, centralized	Integrate gray and green thru distributed approach
Infrastructure integration	Drinking water, stormwater, wastewater managed separately	Integrate as appropriate
Public Involvement	Stakeholders informed of pre-chosen solution	Stakeholders engaged in decision-making
Cost-benefit analysis	Focus on capital and recurring costs	Develop understanding of full cost and benefits

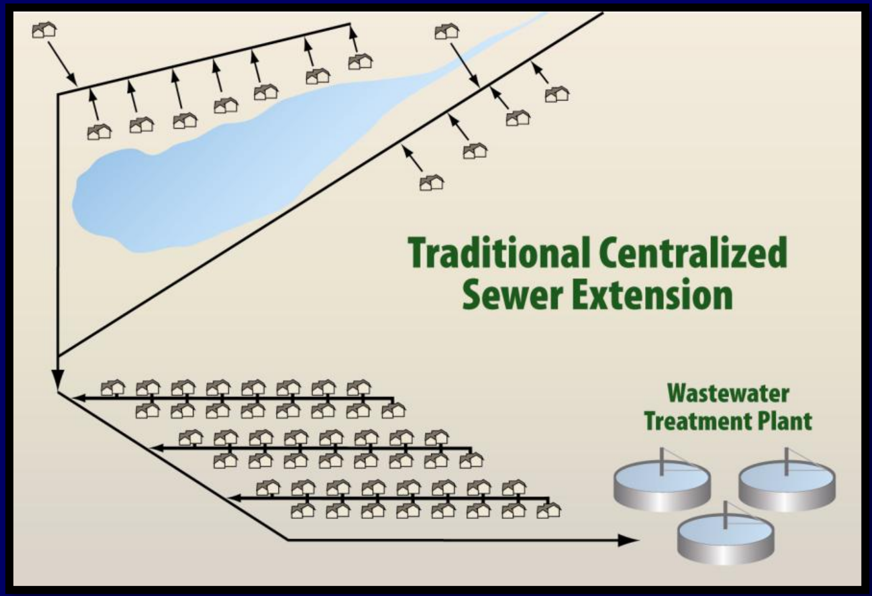
Distributed infrastructure

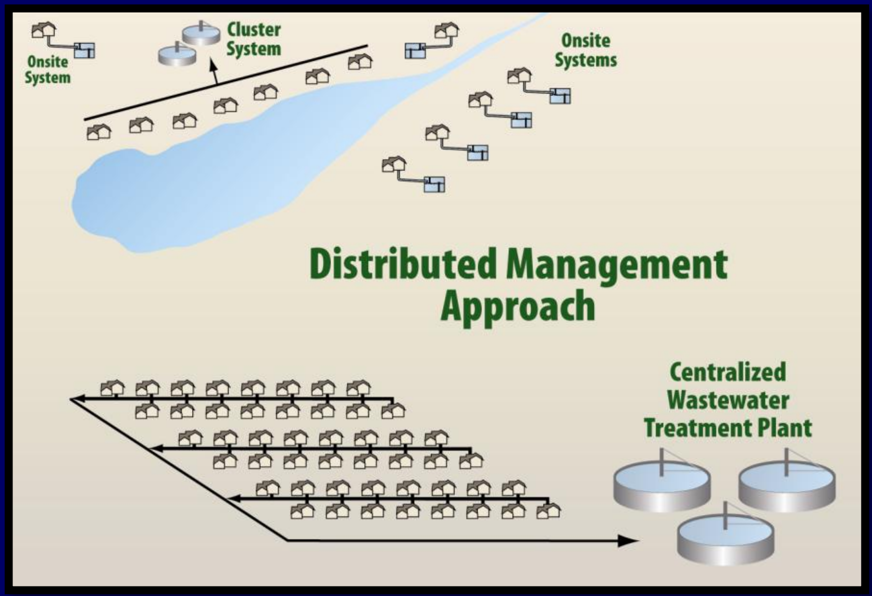
- Integrated infrastructure planning, design, management using systems at various scales, based on context-specific sustainability objectives
  - For stormwater: low-impact design, BMPs
  - For wastewater: onsite to cluster to centralized
  - Centralized oversight generally preferred
  - Part of a green-to-gray built/natural infrastructure strategy



Sustainability drivers and benefits

- Infrastructure funding
- Efficiency
- Integrated resource management
- Multifunctionality





Infrastructure funding

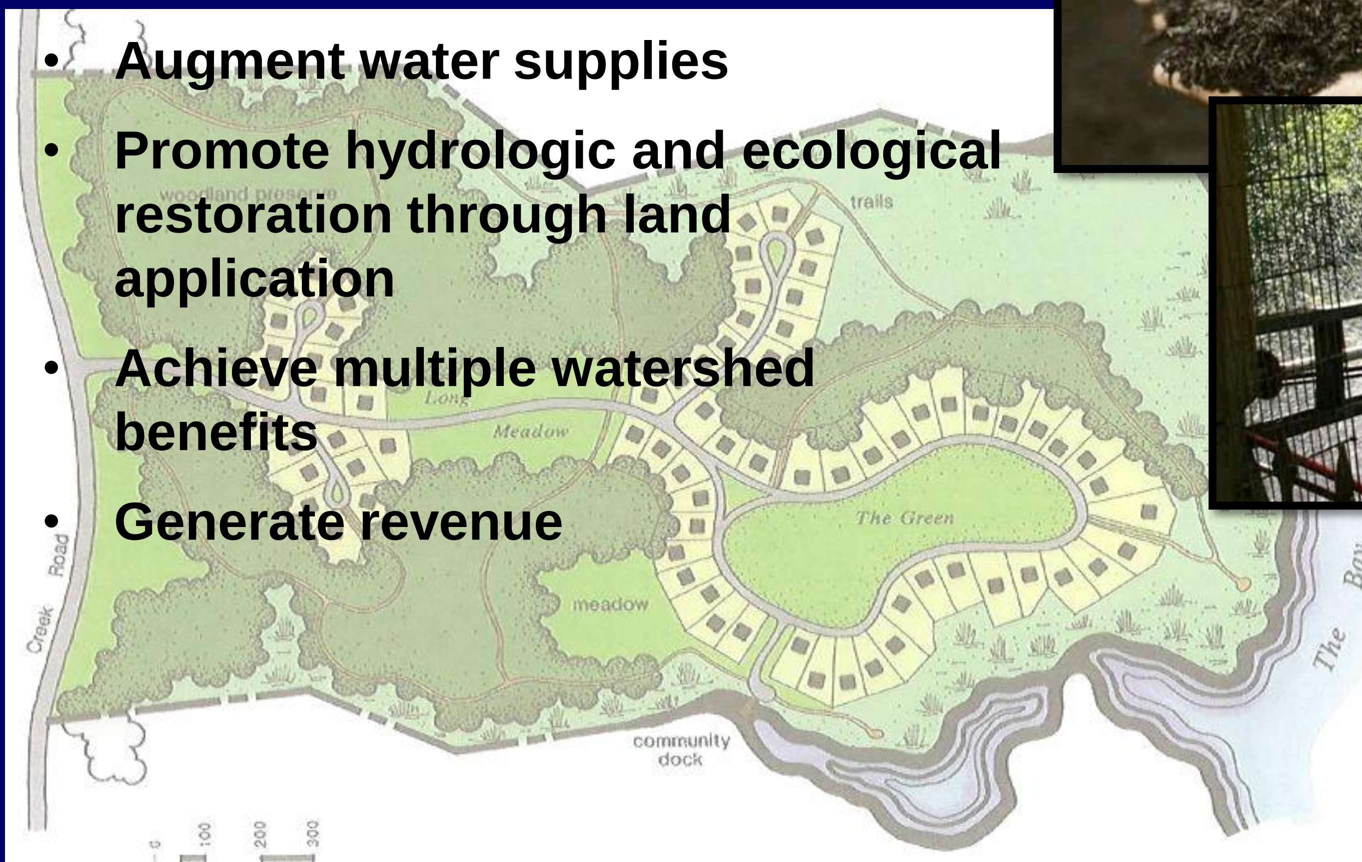
- "Pay as you go/grow" infrastructure can be financed by developers or communities incrementally
  - Traditional infrastructure projects defined by large sunk costs that usually require financing
  - Lower risk with dispersed/diversified infrastructure
- Emerging service delivery mechanisms, funding approaches, business opportunities
  - Design-Build-Operate, Public-(NGO)-Private Partnerships
- New markets and funding sources
  - ARRA GPR – decentralized categorically included
  - Carbon, ecosystem services/banking, nutrient trading markets

Efficiency

- Treatment close to the source and/or reuse requires less energy for conveyance
- Urban reuse retrofits are more feasible and less disruptive
- Source control is energy efficient
- Smart, clean and green technology deployment
  - Smart
    - Remote monitoring of multiple systems
    - Responsive source control and user feedback
  - Clean
    - Resource recovery within facilities
    - Match water quality to intended reuse
  - Green
    - Efficient/passive eco-mimicking treatment systems
    - Landscape/facility integration
    - Relatively infiltration-resistant collection systems

Integrated resource management

- **Integrate water and land management**
- **Close the loop on resource cycles: water, nutrients, carbon/energy, etc.**
- **Augment water supplies**
- **Promote hydrologic and ecological restoration through land application**
- **Achieve multiple watershed benefits**
- **Generate revenue**



Multifunctionality

- Diverse benefits resulting from integration into buildings and sites
  - Resource recovery potential
  - Water reuse/conservation
  - Microclimate energy and comfort
- Environmental and public health protection
- Watershed protection and ecosystem restoration
- Job creation and workforce development
- Multiple human services

When to Consider Distributed Systems in Urban and Suburban Areas

- Water Environment Research Foundation (WERF) funded research project
  - Identify examples of distributed infrastructure approaches in areas where traditional approach would be centralized
  - Study critical path details and decision processes for how these projects were planned and implemented
  - Set forth information using case studies, tools and other communications pieces that help communities make decisions
- Products
  - Case studies and white papers
  - Excel- based MCDA decision-support tool

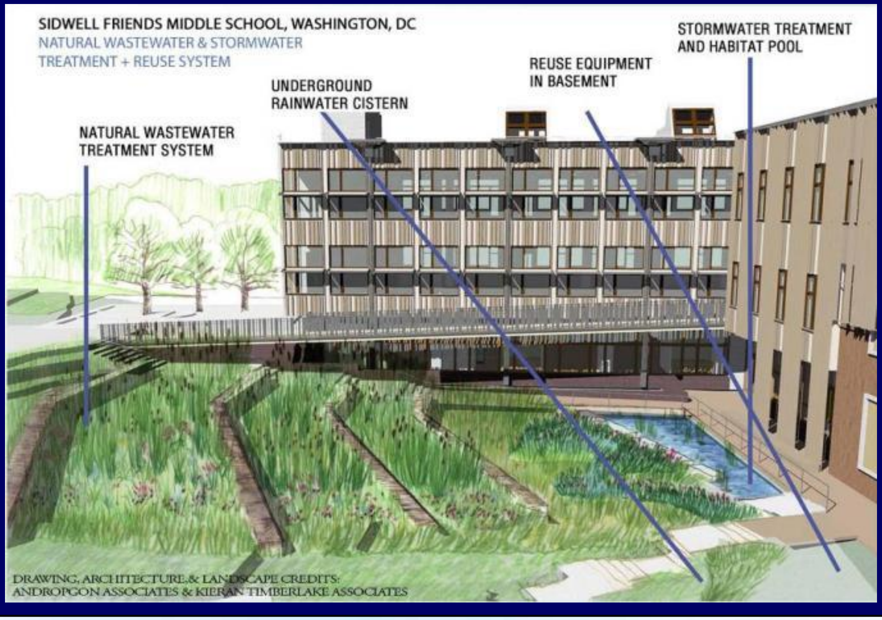
Distributed system applications

- Green Buildings and Sustainable Sites
  - Integration into buildings and landscapes
  - Resource conservation, recovery and reuse within facilities
  - Education and recreation
- Independent Communities
  - Maintain fiscal control
  - Preserve community character
  - Underserved communities
- Utility Optimization
  - Managed distributed systems
  - Sewer mining
  - Satellite reuse

Case Studies Listed by Type
Green Building/Sustainable Sites (GB)
Battery Park City, New York City (UO)
Couran Cove Island Resort, Queensland, Australia (IC)
Currumbin Ecovillage, Queensland, Australia (IC)
Dockside Green, Victoria, British Columbia, Canada (UO)
Philip Merrill Center, Annapolis, Maryland
Sidwell Friends School, Washington, D.C.
Workplace6 Recycled Water Factory, Sydney, Australia (UO)
Independent Communities (IC)
Bethel Heights, Arkansas
Gillette Stadium, Foxborough, Massachusetts (GB)
Lake Elmo, Minnesota
Piperton, Tennessee
Warren, Vermont
Weston Solar Aquatics, Weston, Massachusetts (GB)
Wickford Village, Rhode Island
Utility Optimization (UO)
LOTT Alliance, Lacey, Olympia, and Tumwater, Washington
Loudoun Water, Loudoun County, Virginia (IC)
Mobile Area Water and Sewer System, Mobile, Alabama
Pennant Hills Golf Club, Sydney, Australia
Sand Creek, Aurora, Colorado
University of North Carolina at Chapel Hill, North Carolina (GB)

Sidwell Friends School, Washington, D.C.

- Highly visible, LEED Platinum
- Integrated design team
- 3,000 gpd system for wastewater treatment and reuse are exposed and part of the 'working' landscape of the school's entrance courtyard
  - 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



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, Annapolis, MD

- Chesapeake Bay Foundation Headquarters
- 32,000 sq. foot interpretive center, commercial office (80 people, 40 hours per person per week)
- U.S. Green Building Council LEED-NC, v.1.0 Platinum
  - Solar hot water
  - Rainwater collection
  - Bioretention
  - Habitat restoration
- Waterless composting toilets
  - Reduced water use (only 80 gpd)
  - Reduce nitrogen impacts on bay
  - Compost used as landscape fertilizer

Solaire, Battery Park, Manhattan, NYC

Alliance Environmental LLC

- 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

Dockside Green, Victoria, B.C.

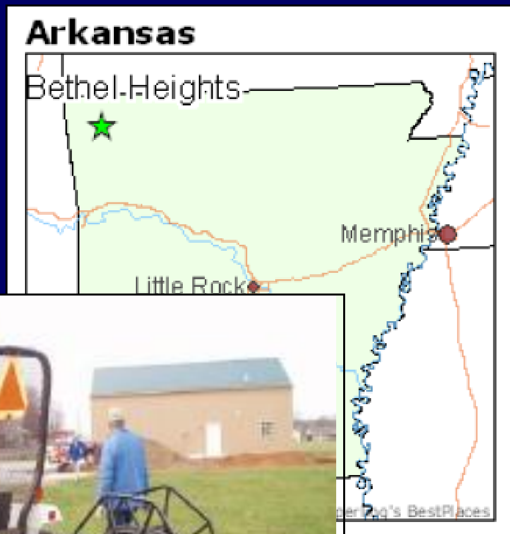
- Water-centric brownfield redevelopment
- On-site, closed-loop treatment provides *fit-for-purpose*, reclaimed water supply (augmented by rainwater)
  - Toilet flushing, landscape irrigation, green roof watering
- Properly functioning stream/pond complex provides residential access, enhancing unit value, ecological function and biodiversity
- On site press for sludge dewatering to produce feedstock for co-located gasification plant
- Single operations company = reduced staffing, maintenance and commissioning, and travel, reducing impact

Courtesy: Dockside Green and Aqua-Tex Scientific

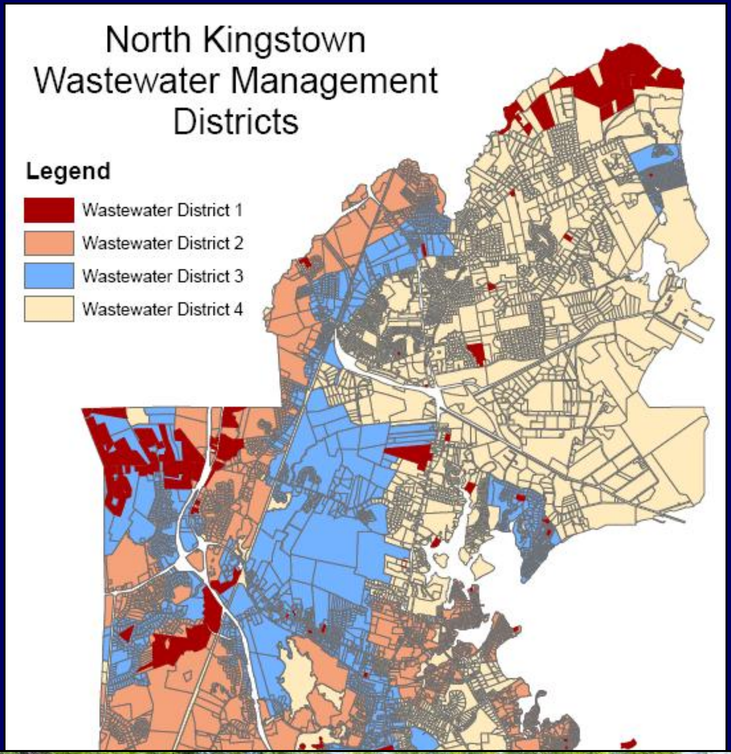
Currumbin Ecovillage, Queensland, Australia

- 144 home sites ~7 km from Currumbin Beach on Queensland's Gold Coast, Australia
- Closed-loop water supply system – disconnected from public water system
- Food producing streetscaping and landscaping
- Intelligent monitoring system (water, gas, electricity) installed at each home
- Each house equipped with rainwater tank(s) that supply all potable water used inside the house
- Wastewater centrally treated to Class A+ reuse standards
  - Textile filters
  - Membrane filtration
  - UV treatment and chlorine disinfection
- Reclaimed water pumped back to the houses for non-potable uses (> 80 percent recycled water use)
  - Toilet-flushing
  - Garden watering
  - Car washing
  - Laundering
  - Fire fighting

Bethel Heights, Arkansas



- Rapidly-growing population relied on individual septic systems
- State law allowing property owners to de-annex from one city and annex to another if their city could not provide wastewater service.
  - City lost tax revenue as residents exercised their right to de-annex.
- City selected two cluster systems phased in to meet increasing demand as the City’s population grew.
  - Septic tank effluent pump (STEP)
  - Modular geotextile packed bed filters
  - Effluent dispersal via drip tubing to irrigate hay fields (hay is cut and shipped out of nutrient-rich watershed)
  - One system irrigates a park and along walking trails.



Wickford Village, RI

- Substandard septic systems in densely settled village in North Kingston
- Concerns about nitrogen loading to Narragansett Bay
- Town chose a decentralized approach to preserve the town's historic character, recharge aquifer and reduce direct nutrient discharge.
- Wastewater management program requires regular inspection and maintenance of septic systems.
- Repairs and upgrades of onsite systems with advanced technologies were incentivized for homeowners in high-risk areas.
- Priority areas were established to better match treatment technology and grant funding with environmental sensitivity.

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^2 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
  - 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)
  - Growth pays for growth: developers design and construct facilities to Loudoun Water standards and at no cost to Loudoun Water
- Shared review and approval responsibilities
  - Indiv. 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

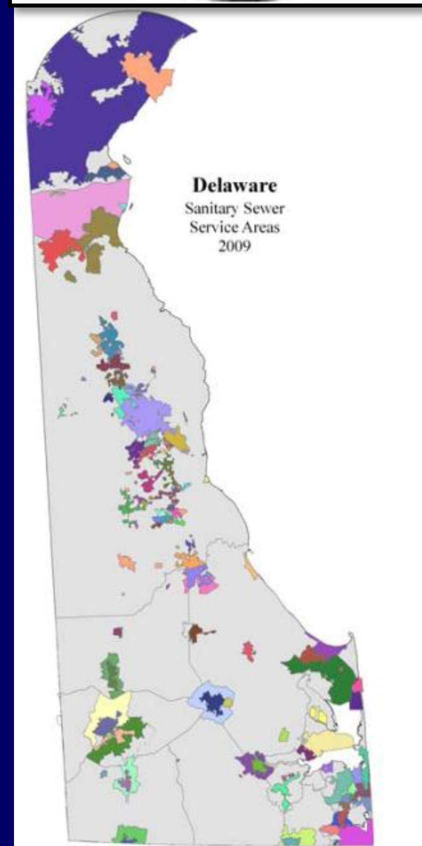
- Lacey-Olympia-Tumwater urban area
- 20-year plan calls for construction of three satellite reclaimed water treatment plants
- Each satellite built in small increments to allow "just-in-time" construction for future needs
- Budd Inlet Plant
  - 12 MGD advanced secondary treatment with nitrogen removal and UV
  - 1 MGD is fed to reclamation plant with continuously back-flushing sand filter system and sodium chloride disinfection
  - Meets Washington State's Class A Reclaimed Water standards for irrigation, equipment washdown, dust suppression, cleaning, etc.
- Hawks Prairie Reclaimed Water Satellite
  - MBR producing 2 MGD class A reuse water, expandable to 5 mgd
  - Reclaimed water feeds constructed wetland ponds/groundwater recharge basins
  - Provides opportunities for public education, recognition, and acceptance of reclaimed water
  - Serves as an amenity for visitors

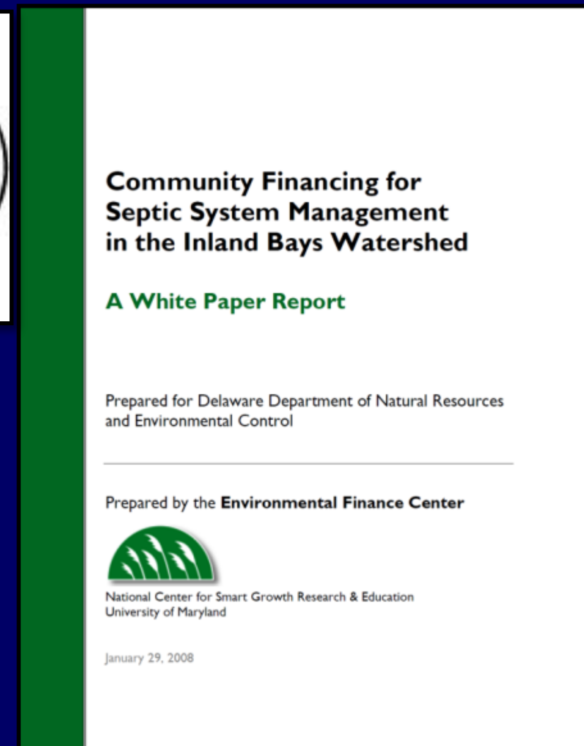
Clean Water Services Hillsboro, OR

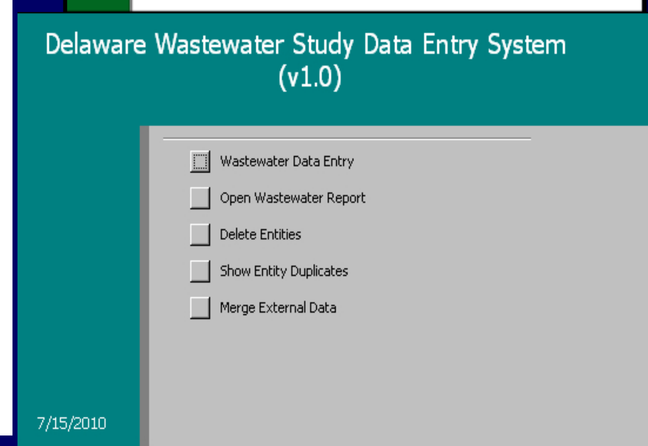
- Ostara Nutrient Recovery System
- Controlled formation of mineral struvite recovers phosphorous and nitrogen
- Product sold as slow-release fertilizer
- Uncontrolled struvite formation clogs pipes and equipment
- Payback period < 5 years

Delaware Statewide Assessment of Wastewater Facilities and Service Areas

- Database of state/federal data and survey utilities
  - Municipal utilities
  - 281 decentralized systems
  - Two private utilities
- Current and future financing needs based on 2010 PPL
- User rates/fees and assessment of ability to pay for services
- Aerial survey/study of septic systems
- Beneficial reuse study
  - Opportunities/interest
  - Technological options

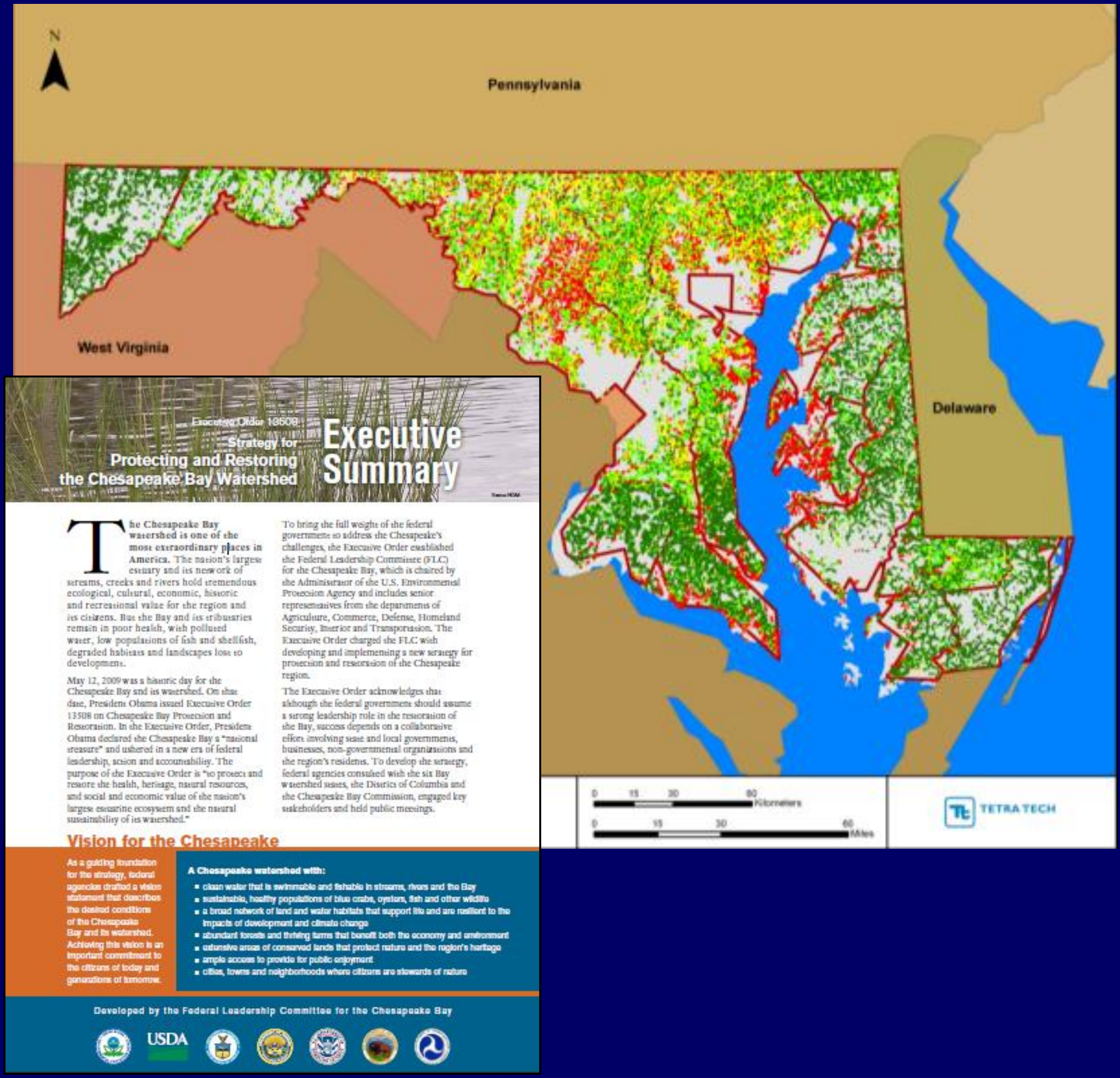






Maryland Gap Closer Analysis for Chesapeake Bay TMDL Implementation

- US EPA support for states to implement nutrient TMDL
- Statewide plan for reducing nutrients from existing decentralized systems
  - Loading analysis
  - Reduction analysis
    - Onsite upgrades
    - Clustering
    - Sewering



Executive Order 13508

Strategy for Protecting and Restoring the Chesapeake Bay Watershed

Executive Summary

The Chesapeake Bay watershed is one of the most extraordinary places in America. The nation's largest estuary and its network of streams, creeks and rivers hold tremendous ecological, cultural, economic, historic and recreational value for the region and its citizens. But the Bay and its tributaries remain in poor health, with polluted water, low populations of fish and shellfish, degraded habitats and landscapes lost to development.

May 12, 2009 was a historic day for the Chesapeake Bay and its watershed. On that date, President Obama issued Executive Order 13508 on Chesapeake Bay Protection and Restoration. In the Executive Order, President Obama declared the Chesapeake Bay a "national treasure" and ushered in a new era of federal leadership, action and accountability. The purpose of the Executive Order is "to protect and restore the health, heritage, natural resources, and social and economic value of the nation's largest estuarine ecosystem and the natural sustainability of its watershed."

To bring the full weight of the federal government to address the Chesapeake's challenges, the Executive Order established the Federal Leadership Committee (FLC) for the Chesapeake Bay, which is chaired by the Administrator of the U.S. Environmental Protection Agency and includes senior representatives from the departments of Agriculture, Commerce, Defense, Homeland Security, Interior and Transportation. The Executive Order charged the FLC with developing and implementing a new strategy for protection and restoration of the Chesapeake region.

The Executive Order acknowledges that although the federal government should assume a strong leadership role in the restoration of the Bay, success depends on a collaborative effort involving state and local governments, businesses, non-governmental organizations and the region's residents. To develop the strategy, federal agencies consulted with the six Bay watershed states, the District of Columbia and the Chesapeake Bay Commission, engaged key stakeholders and held public meetings.

Vision for the Chesapeake

As a guiding foundation for the strategy, federal agencies drafted a vision statement that describes the desired conditions of the Chesapeake Bay and its watershed. Achieving this vision is an important commitment to the citizens of today and generations of tomorrow.

A Chesapeake watershed with:

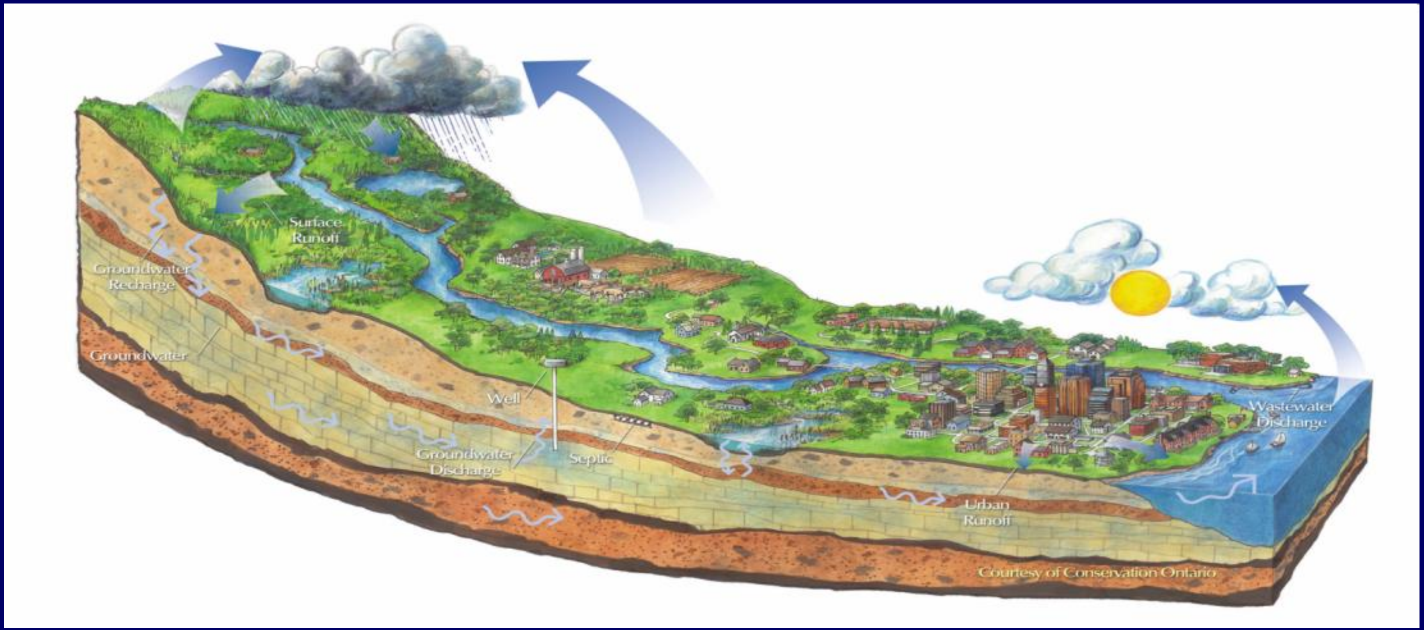
- clean water that is swimmable and fishable in streams, rivers and the Bay
- sustainable, healthy populations of blue crabs, oysters, fish and other wildlife
- a broad network of land and water habitats that support life and are resilient to the impacts of development and climate change
- abundant forests and thriving farms that benefit both the economy and environment
- extensive areas of conserved lands that protect nature and the region's heritage
- ample access to provide for public enjoyment
- cities, towns and neighborhoods where citizens are stewards of nature

Developed by the Federal Leadership Committee for the Chesapeake Bay

USDA

Sustainability metrics

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



Decision support

- Alternative infrastructure approaches considered only in cases where traditional centralized models are grossly impractical
  - Capital improvement planning typically only considers study, design, permitting, capital and recurring costs
  - Funding mechanisms and regulatory programs evolved by targeting gross surface water pollution
  - Critical paths for successfully implementing centralized systems are understood and the “default”
- Techniques can be used to factor externalities into infrastructure decision making, yielding a more equitable and robust comparison of alternatives
  - Multi-Criteria Decision Analysis (MCDA)
  - Full Cost Accounting

Decentralized Wastewater Stakeholders Decision Model

Economic

Maximize Economic Value

Minimize Capital Costs

- Planning and Design
- Land
- Phasing
- Existing Treatment
- Existing Collection
- Financing

Minimize Operating Costs

- Financing Cost
- Labor
- Power
- Byproducts
- Other

Meet Community Economic Needs

- Availability
- Adaptability
- Externalities

Environmental

Optimize Environmental Benefit

Water Quality

- Avoidance
- Removal

Water Quantity

- Water Balance
- Sustain Flow

Natural Environment

- Biodiversity
- Disturbance
- Global Warming

Societal

Fulfill Community Objectives

Quality of Life

- Health
- Outdoor Environment
- Built Environment

Stability

- Dependable
- Resilient
- Safe

Equitability

- Serves All Equally
- Charges Everyone Fairly

Decentralized Wastewater Stakeholders Decision Model

WERF
Decentralized Wastewater Stakeholder Decision Model

Step 1: Objectives and Their Importance

Reset | Results | Next Step ==>

Objectives	Rate Importance (0 to 5)	Weights
1. Maximize Economic Value		0%
1.1 Minimize Capital Costs	0	
1.2 Minimize Operation and Maintenance (O&M) Costs	0	
1.3 Meet Community Economic Needs	0	
2. Optimize Environmental Benefits		0%
2.1 Improve and Protect Drinking Water Supplies	0	
2.2 Improve and Protect Surface Water Quality	0	
2.3 Assure Water Quantity	0	
2.4 Protect Natural Environment	0	
3. Fulfill Community Objectives		0%
3.1 Quality of Life	0	
3.2 Stability	0	
3.3 Equitability	0	
Total Project		**0.00%**

Minimize Operating Cost – Ongoing costs for running the system and includes many factors such as labor, power, and cost of debt financing. This cost directly affects the user rates because no outside subsidies are available to offset them.

Meet Community Economic Needs – What role does this project play in economically sustaining or enhancing the community? Does it drastically affect property values and does it allow for community-desired commercial business expansion?

Optimize Environmental Benefit

Improve and Protect Water Quality – Most wastewater projects are primarily aimed at protecting water quality by avoiding contamination that denigrates aquatic life and at providing clean water for consumption, ecological improvement, and expanded recreation

Decentralized Wastewater Stakeholders Decision Model

WERF

Decentralized Wastewater Stakeholder Decision Model

Step 2: Value the Attributes of Each Objective (Page 1 of 10)

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1.1 Minimize Capital Costs

Reducing capital costs may allow a community to make the initial investment to start a project sooner. Decentralized wastewater approaches may help reduce capital costs. Several components of capital costs must be analyzed.

Attribute		Strongly Favors Decentralized	Slightly Favors Decentralized	Neutral	Slightly Favors Centralized	Strongly Favors Centralized	Not Applicable
1.1.1. Financing Costs – Can vary significantly over time and between locations and projects; requires careful investigation.	More Info	○	○	○	○	○	●
1.1.2. Planning and Design - Planning and design costs constitute a larger percentage of the total budget for smaller decentralized wastewater systems. These costs typically are lower for large, centralized projects primarily because of engineers' prior experience with these technologies and some economies of scale, although this will vary significantly depending on the specifics of the project.	More Info	○	○	○	○	○	●
1.1.3. Construction Inspection – Primarily related to the complexity of the wastewater treatment and collection system, inspection of both centralized sewers and decentralized systems requires fulltime inspectors. The duration of the construction process for decentralized systems, however, typically is much shorter and less disruptive to existing transportation system and community.	More Info	○	○	○	○	○	●
1.1.4. Land – Composes a significant portion of capital costs unless the land is owned by the municipality or can serve multiple purposes.	More Info	○	○	○	○	○	●
1.1.5. Phasing – Dividing a project into smaller phases can reduce capital costs.	More Info	○	○	○	○	○	●
1.1.6. Optimizing Existing Treatment Plant Infrastructure - Small, decentralized approaches can extend the life expectancy of existing centralized treatment plants, thereby reducing capital costs.	More Info	○	○	○	○	○	●
1.1.7. Optimizing Existing Collection System Infrastructure - Expansion or replacement of collection systems, pump stations, and transmission mains can be reduced by using smaller-scale decentralized approaches.	More Info	○	○	○	○	○	●

Decentralized Wastewater Stakeholders Decision Model

WERF

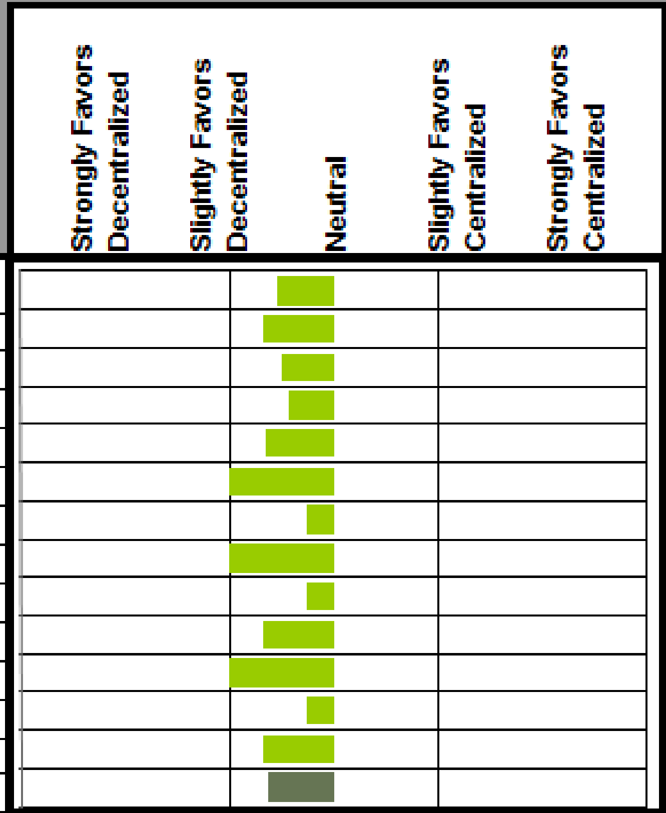
Decentralized Wastewater Stakeholder Decision Model

Results

Home

- 1 Maximize Economic Value
  - 1.1 Minimize Capital Costs
  - 1.2 Minimize Operation and Maintenance (O&M) Costs
  - 1.3 Meet Community Economic Needs
- 2 Optimize Environmental Benefits
  - 2.1 Improve and Protect Drinking Water Supplies
  - 2.2 Improve and Protect Surface Water Quality
  - 2.3 Assure Water Quantity
  - 2.4 Protect Natural Environment
- 3 Fulfill Community Objectives
  - 3.1 Quality of Life
  - 3.2 Stability
  - 3.3 Equitability

Summary Score



The results above indicate your preference for a centralized versus decentralized approach for each of the categories your ranked. Your overall score is shown in the final "Summary Score" at the bottom. If you go back and change your answers, these scores will recalculate.

Building institutional capacity

- Integrated planning and smart growth
- Watershed scale planning and management
- Full life-cycle costing
- Improved regulations
- Enhanced community engagement
- Investment in intellectual capital
- Improved market mechanisms

Additional information

Distributed Water Infrastructure for Sustainable Communities

A Guide for Decision-Makers

New, more sustainable water infrastructure systems are emerging in rural, suburban, and urban communities across the United States and abroad. These new infrastructure models integrate decentralized systems within traditional, centralized conveyance and treatment networks in an approach called *distributed management*. Leading edge communities are recognizing that these strategies—which integrate water management at the individual site scale, to residential neighborhoods and small communities, to an entire watershed or region—are more efficient and effective across a triple bottom line of environmental, social, and economic considerations.

The research project, When to Consider Distributed Systems in an Urban and Suburban Context, analyzed 20 case studies where distributed approaches are being used to provide integrated water services across a range of community-specific situations and management frameworks in the United States and Australia. This project was sponsored by the Water Environment Research Foundation (WERF) and the National Decentralized Wastewater Resource Capacity Development Project (NDWRCDP) to help planners, utility managers, engineers, developers, regulators and other decision-makers determine whether they should consider using a distributed approach in urban and suburban areas—or in areas where users might normally be served by centralized systems.

An analysis of representative case studies showed that there were three primary applications for distributed systems. In some cases, property owners or developers were driven by a desire to construct green buildings, which often can make the development more attractive to future residents or consumers. This decision often aligns with the developer's core values to build sustainably. In other cases, smaller communities are using distributed systems to preserve their area's unique character by preventing unwanted growth and change often associated with larger, centralized systems. These communities are able to maintain their social and fiscal independence by not connecting to another community's sewer system or by incurring the large upfront costs and associated debt of building a cen-

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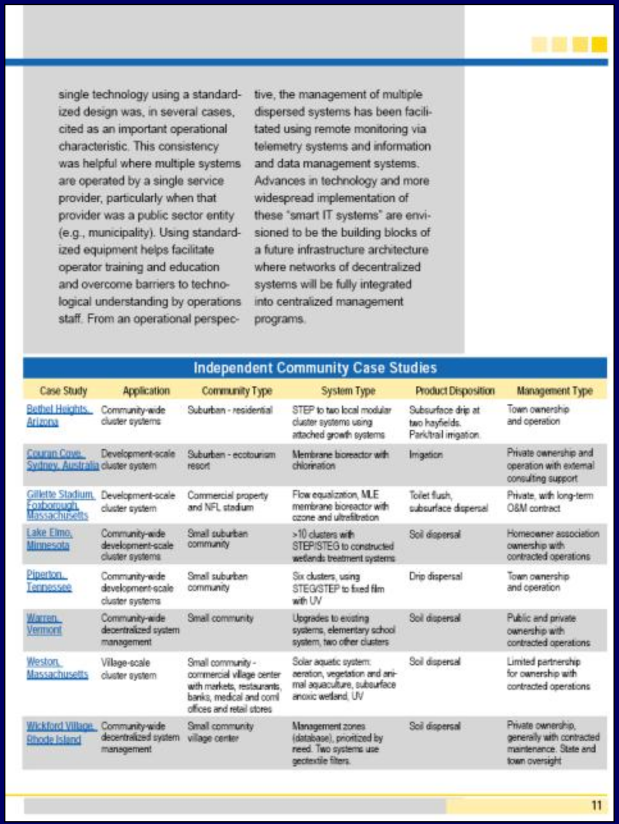

single technology using a standardized design was, in several cases, cited as an important operational characteristic. This consistency was helpful where multiple systems are operated by a single service provider, particularly when that provider was a public sector entity (e.g., municipality). Using standardized equipment helps facilitate operator training and education and overcome barriers to technological understanding by operations staff. From an operational perspective, the management of multiple dispersed systems has been facilitated using remote monitoring via telemetry systems and information and data management systems. Advances in technology and more widespread implementation of these "smart IT systems" are envisioned to be the building blocks of a future infrastructure architecture where networks of decentralized systems will be fully integrated into centralized management programs.

Independent Community Case Studies

Case Study	Application	Community Type	System Type	Product Disposition	Management Type
Bethel Heights, Arizona	Community-wide cluster systems	Suburban - residential	STEP to two local modular cluster systems using attached growth systems	Subsurface drip at two hayfields. Park/trail irrigation.	Town ownership and operation
Couran Cove, Sydney, Australia	Development-scale cluster system	Suburban - ecotourism resort	Membrane bioreactor with chlorination	Irrigation	Private ownership and operation with external consulting support
Gillette Stadium, Foxborough, Massachusetts	Development-scale cluster system	Commercial property and NFL stadium	Flow equalization, MLE membrane bioreactor with ozone and ultrafiltration	Toilet flush, subsurface dispersal	Private, with long-term O&M contract
Lake Elmo, Minnesota	Community-wide development-scale cluster systems	Small suburban community	>10 clusters with STEP/STEG to constructed wetlands treatment systems	Soil dispersal	Homeowner association ownership with contracted operations
Piperton, Tennessee	Community-wide development-scale cluster systems	Small suburban community	Six clusters, using STEG/STEP to fixed film with UV	Drip dispersal	Town ownership and operation
Warren, Vermont	Community-wide decentralized system management	Small community	Upgrades to existing systems, elementary school system, two other clusters	Soil dispersal	Public and private ownership with contracted operations
Weston, Massachusetts	Village-scale cluster system	Small community - commercial village center with markets, restaurants, banks, medical and coml offices and retail stores	Solar aquatic system: aeration, vegetation and animal aquaculture, subsurface anoxic wetland, UV	Soil dispersal	Limited partnership for ownership with contracted operations
Wickford Village, Rhode Island	Community-wide decentralized system management	Small community village center	Management zones (database), prioritized by need. Two systems use geotextile filters.	Soil dispersal	Private ownership, generally with contracted maintenance. State and town oversight

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When to Consider Distributed Systems in an Urban and Suburban Context

WERF

CASE STUDY: BATTERY PARK CITY URBAN WATER REUSE

SYSTEM DESCRIPTION

Location: New York City (latitude: 40° 42' 10" N; longitude: 74° 00' 59" W)

Collection: Each building in Battery Park City has its own internal wastewater collection system that is interconnected to the New York City (NYC) sanitary wastewater collection and treatment system. This system consists of pipes in the public right-of-way that existed before construction of these buildings. The NYC water and sewer systems were upgraded or relocated where necessary, but their previous function and capacity remained unchanged. The stormwater system was built independently and discharges directly to the Hudson River. The sanitary wastewater system discharges to a NYC combined sewer that serves the lower portion of Manhattan.

Treatment: Each project provides adequate treatment for the intended use of the reclaimed rainwater or wastewater. Rainwater is collected from vegetated green roofs and membrane roofs and stored in tanks that include varying degrees of filtration and disinfection. Wastewater and, in certain cases, combined rainwater and wastewater, is treated using membrane bioreactor (MBR) technology. The primary means of disinfection is UV and ozone which is used primarily to eliminate color by oxidizing any remaining low-concentration organic compounds, and it also provides an additional means of disinfection.

Product disposition: Product reuse water is typically stored in individual reservoirs located in each building and subsequently distributed based on demand. The nonpotable water distribution system draws water from the reservoirs, which are then replenished with additional reuse water from the treatment process. Reclaimed water is used for toilet flushing, cooling, laundry, and irrigation. Potable water is provided by the NYC public water supply system.

Flowrate: The total reclaimed water flow within Battery Park City will be 662 m^3/d (175 000 gpd) from six separate systems when all of the buildings are complete.

Service Area: A mixed-use community of residential, commercial, and institutional properties. There is no defined service area because each building provides its own internal nonpotable

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- www.werf.org/distributedwater
- http://www.ndwrcdp.org/research_project_DEC6SG06a.asp
- Decentralized Water Resource Collaborative : www.ndwrcdp.org

Thank You!

Date	Topics (All @ 12 noon EST)	Presenter
November 9	***Overview of Centralized and Decentralized Treatment***	*Barry Tonning*
November 16	***Decentralized Treatment: Processes & Technologies***	*Jim Kreissl*
November 23	***Focus on Wastewater System Design: Part 1***	*Vic D'Amato*
November 30	***Focus on Wastewater System Design: Part 2***	*Vic D'Amato*
December 7	***Management Approaches for Wastewater Systems***	*Juli Beth Hinds & Khalid Alvi*
December 14	***Integrated Water Resource Management***	*Vic D'Amato*