Green Infrastructure Webcast Series

Revising Local Plans, Codes and Ordinances
Water Harvesting

Guide to Our Webcasts

For Technical Support click the "*Help*" button

- *To Ask a Question* - Type your question in the text box located in the lower left-hand corner of your screen and click on the "Submit Question" button
- *To Answer a Poll Question* – Click on the radio button to the left of your choice and click submit. Do not type your answer in the "Ask a Question" box
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Green Infrastructure Webcast Series

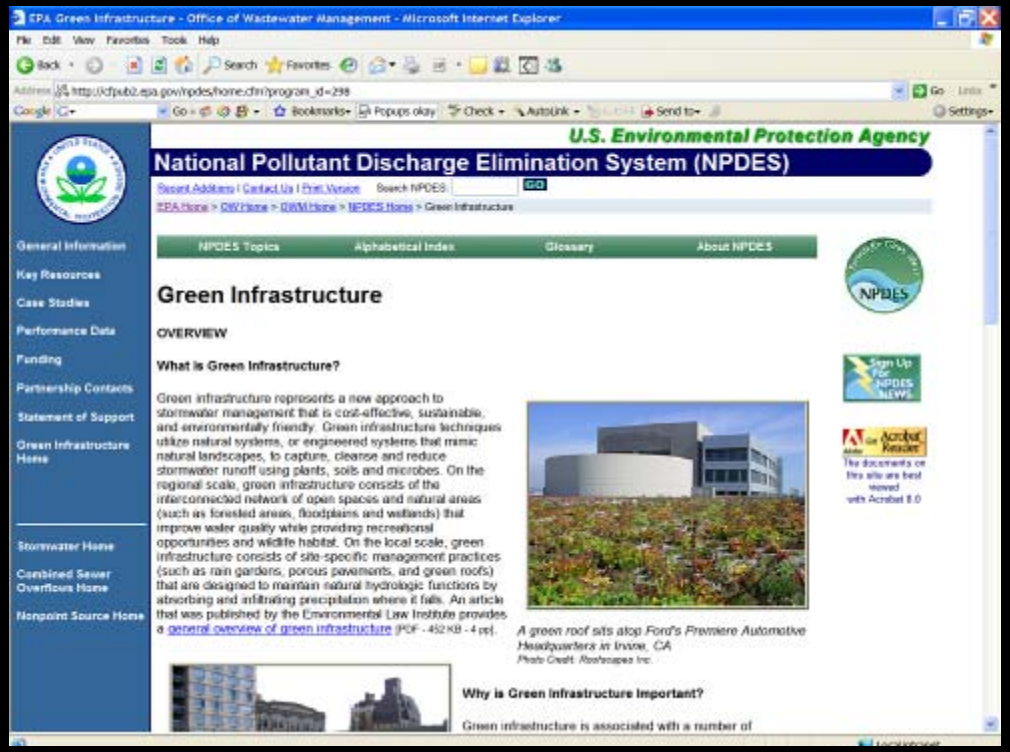
Tuesday, April 28, 2009
- Models & Calculators
- Municipal Case Study: Louisville

Tuesday, May 12, 2009
- Site Planning & Design Considerations
- Costs and WERF Cost Tool

Tuesday, June 23, 2009
- Funding & Incentives
- Brownfield Redevelopment

Tuesday, July 28, 2009
- Retrofits: Green Streets
- Operation & Maintenance

Green Infrastructure Website
www.epa.gov/greeninfrastructure



- General Information
- Key Resources
- Case Studies
- Performance Data
- Partnership Contacts
- Statement of Support

Green Infrastructure Codes and Ordinances

Abby Hall
EPA Headquarters
Office of Policy, Economics and Innovation

Green Infrastructure at 3 Scales

- Site
  - Rain gardens, green roofs, pervious pavers
- Neighborhood
  - Street networks, parking, mixed use
- Municipal
  - Open space, infill development, trees

Land Use and Water Quality

- **Preserve**: Protect and enhance natural features, such as undisturbed forests, meadows, wetlands, and other natural areas.
- **Recycle**: Recycle land by directing development to already degraded land, e.g., parking lots, vacant buildings, abandoned malls.
- **Reduce**: Reduce land consumption and development footprint by using land efficiently.
- **Reuse**: Capture and reuse stormwater by directing it back into the into the ground through infiltration, evapotranspiration, or reuse.

Preserve

- Preserve large, continuous areas of open space
- Preserve sensitive ecological areas

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Recycle

- Direct development to already degraded lands

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Reduce Imperviousness

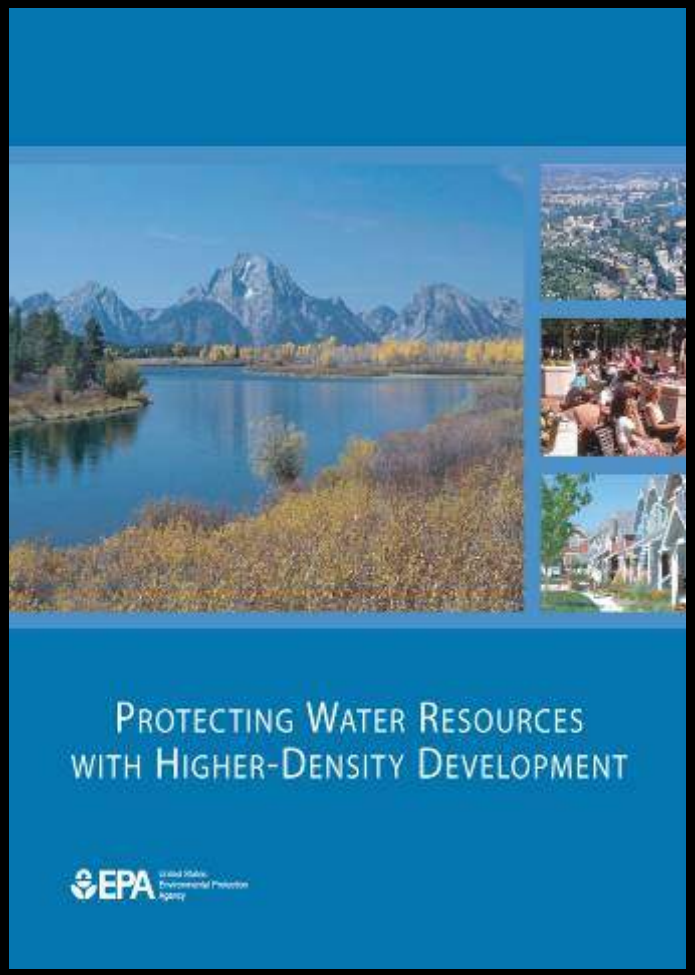
Low Density

Higher Density

Smart Growth and Water

Smart Growth Principles

- Increased Density
- Transit and Pedestrian Accessibility
- Infill and Brownfield Development
- Bridging Institutional Barriers



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Green Infrastructure

Benefits of Green Infrastructure

- Urban heat island reduction
- Reduced energy demands
- Improved air quality
- Recreational space
- Walkable streets
- Increased land values
- Quality of life
- And more…

Comprehensive Program

- Land use planning
- Land acquisition and capital investments
- Internal policies
- Codes and ordinances

EPA's Water Quality Scorecard

- Drivers of impervious cover at regional, neighborhood, site scales
- Requires cooperation and conversation between numerous departments
- Identifies 21 broad policy areas across 5 different municipal departments
- More than 230 different policies, codes, or incentives a local government could implement

4 Ways to Impact Change

- Adopt Plans
- Remove Barriers
- Create Incentives
- Enact Regulations

Water Quality Scorecard

1. Protect Natural Resources and Open Space
2. Promote Compact Development and Infill
3. Design Complete, Smart Streets that Reduce Imperviousness
4. Encourage Efficient Parking Supply
5. Green Infrastructure On Site

1. Protect Natural Resources and Open Space

- Natural Resource Protection
- Open Space Protection
- Tree Protection

1.A—Natural Resource Protection	Implementation Tools and Policies	Points Available	Points Received or N/A	Notes and Local References
(2) Protection Of Water Bodies/Aquifers **a. Question:** Are no-development buffer zones and other protective tools in places around wetlands, riparian areas, and flood plains that improve/protect water quality? **Goal:** Protect critical areas such as wetlands, floodplains, lakes, rivers, and estuaries with a mandatory no-development buffer. **Why:** This will limit pollutant loads and hydrologic alterations to water bodies.	**Adopt Plans/Educate:**			
	• The local government has identified and mapped critical water resource areas.	1		
	• The local comprehensive plan contains a water quality protection element with goals calling for protection of identified water bodies and other water resource areas such as wetlands.	1		
	• Key critical water resource areas are identified for protection in jurisdiction's parks and open space plan.	1		
	• The local government has cooperated in developing regional approaches to watershed protection and stormwater management.	1		
	Remove Barriers:			
	• Wetlands and other water bodies and buffer areas qualify for credit against local open space dedication/set-aside regulations.	1		
	Adopt Incentives:			
	• Protected water bodies and buffer areas qualify for 2X (or more) credit against open space requirements set by the municipality.	1		
	• Restoration of degraded riparian/wetland areas qualifies for additional open space credit within the local municipal system.	1		
	• Density from protected riparian areas/buffers can be transferred to upland portion of development sites.	1		

2. Promote Compact Development and Infill

- Support Infill and Redevelopment
- Direct Development to Existing Infrastructure
- Encourage Mixed-Use Development

2.A— Direct Development To Existing Infrastructure	Implementation Tools and Policies	Points Available	Points Received or N/A	Notes and Local References
(1) Question: Is growth directed to areas with existing infrastructure, such as sewer, water, and roads? **Goal**: Policies, incentives, and regulations direct new development to areas that have existing infrastructure, such as water and sewer. However, in situations where development is sited in areas with no sewer infrastructure, permitting alternative treatment options that can allow for higher density development or clustering of houses will reduce the overall WQ impact.	**Adopt Plans/Educate:** • Local plans recommend/establish urban growth areas and urban growth boundaries. Development is encouraged within urban growth boundaries and discouraged outside of it. • Local government has analyzed which areas within the jurisdiction are appropriate for higher density development based on existing infrastructure capacity, cost of providing new services, and access. • Capital improvement plans for public infrastructure (roads, water, sewer, etc.) target funding inside urban growth boundary. • Local sewer/water authority capital improvement plans follow development policies established in local comprehensive plans and target areas with existing development/infrastructure.	1 2 2 1		
	Remove Barriers: • Development standards addressing landscaping, buffering, parking, and open space are tailored for infill areas to avoid creating unnecessary hurdles to development (e.g., imposing suburban parking requirements in high-density infill areas). • Remove prohibitions on accessory dwelling units in infill areas to increase density of development.	2 2 2		

3. Design Complete, Smart Streets

- Street Design
  - Context sensitive solutions
  - Narrow streets
  - Driveway location/design

- Green Infrastructure Designs
  - Standards and Design Criteria
  - Construction
  - Maintenance

3.A—Street Design	Implementation Tools and Policies	Points Available	Points Received or N/A	Notes and Local References
(2) Question: Are shared driveways, reduced driveway widths, two-track driveways, and rear garages and alleys encouraged for all single-family developments? **Goal:** Encourage alternative forms and decreased dimensions of residential driveways and parking areas. **Why:** Off-street parking and driveways contribute significantly to the impervious areas on a residential lot. Reducing such dimensions can minimize the amount of stormwater runoff from a site.	**Adopt Plans/Educate:**			
	Remove Barriers: • Developments that utilize shared driveways and rear-loaded garages to reduce impervious cover allowed to permit overnight parking in driveways and on-street. • Development code prohibits homeowner covenants forbidding overnight parking in driveways, on-street overnight parking and shared driveways.	**1** **1**		
	Adopt Incentives: • Developments with narrow driveways and rear-loaded garages allowed to reduce number of parking spaces for guests. Zoning/subdivision regulations require minimum number of connections between new project and surrounding developments and neighborhoods.	**1** **1**		
	Enact Regulations: • Shared driveways are permitted or required for single-family residential developments. • Minimum widths for single-family driveways reduced to 9 feet. • Two-track driveways allowed by technical street/subdivision specifications. • Single-family residential developments encouraged/required to be designed with minimum percentage of alley-accessible, rear-loading garages. --Alleys/garages encouraged = 1 points --Alleys/garages required = 2 points	**1** **1** **1** **1 to 2 points**		

4. Encourage Efficient Parking Supply

- Reduce Parking Requirements
- Transportation Demand Management
- Minimize Stormwater from Parking Lots

4.A—Reduced Parking Requirements	Implementation Tools and Policies	Points Available	Points Received or N/A	Notes and Local Resources
(1) Question: Does your local government provide flexibility regarding alternative parking requirements (e.g., shared parking, off-site parking) and discouraged over-parking of developments? Do parking requirements vary by zone to reflect places where more trips are made on foot or by transit? **Goal:** Match parking requirements to the level of demand and allow flexible arrangements to meet parking standards. **Why:** Inflexible parking requirements that do not allow for alternative approaches and standards that require too much parking for specific uses increase the amount of impervious surface in a development. Over-parking a development also encourages greater vehicle use and detracts from the overall pedestrian environment.	**Adopt Plans/Educate:** • The comprehensive plan recognizes the advantages to reduced parking requirements generally and specifically for mixed-use and transit-oriented developments. • The comprehensive plan recommends alternative, flexible approaches to meeting parking demands (e.g., shared parking, counting on-street spaces towards site parking requirements, etc.) • Comprehensive/bicycle plans recommend provision of bicycle parking spaces/storage lockers and concomitant reduction in vehicle parking space requirements.	1 1 1		
	Remove Barriers: • Allow flexibility in meeting parking space requirements through shared parking, off-site parking, and similar approaches. • Permit businesses with different peak demand periods to share their required parking spaces.	1 1		
	Adopt Incentives: • Permit reduction in vehicle parking spaces when minimum number of bicycle parking spaces provided. • Allow by-right reduction in parking spaces required (e.g., 25%) in mixed-use and transit-oriented developments and districts. • Permit developers to undertake parking studies to establish that specific developments (e.g., senior housing, affordable housing) require fewer parking spaces than typical projects.	1 1 1 1		

5. Green Infrastructure On Site

- Green Infrastructure Practices
  - Allowed for residential management
  - Required for new developments
- Maintenance and Enforcement
  - Monitoring, tracking and maintenance protocols

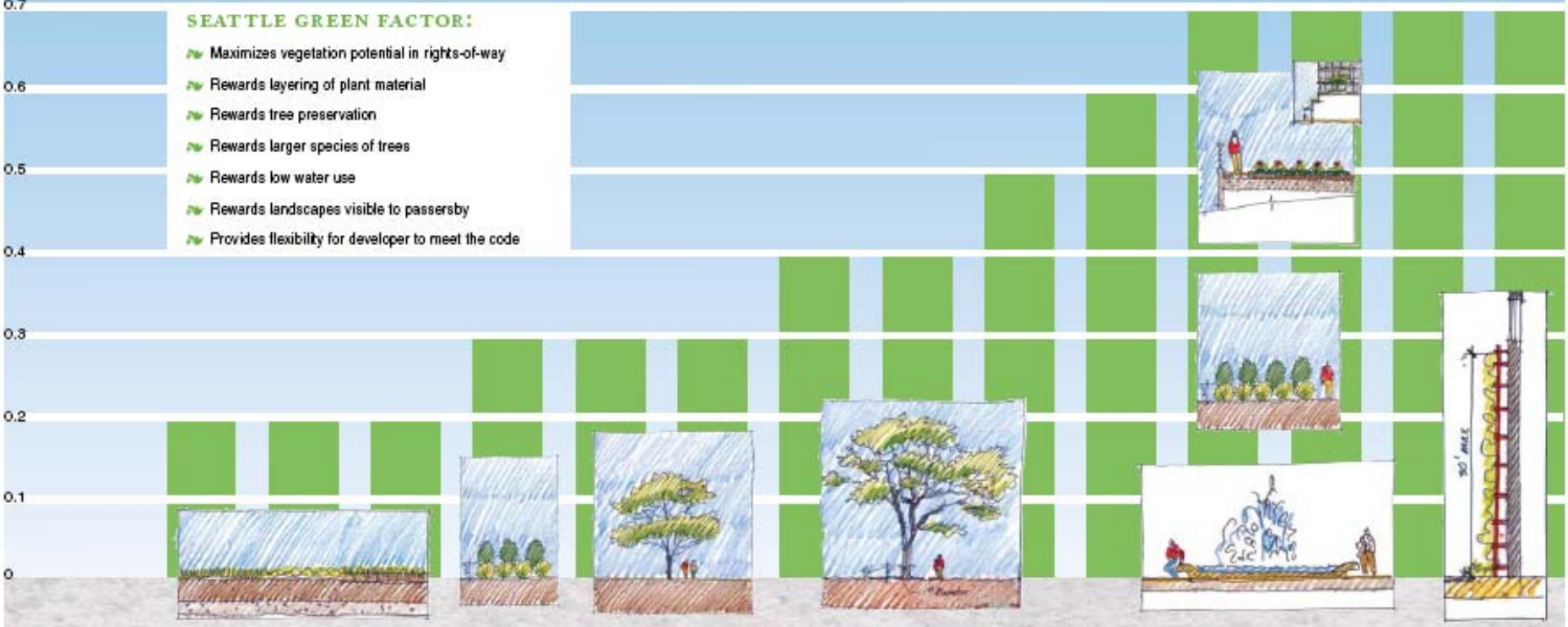
5.A—Green Infrastructure Practices	Implementation Tools and Policies	Points Available	Points Received or N/A	Notes and Local References
(3) Question: Do local building and plumbing codes allow harvested rain water for non-potable interior uses such as toilet flushing? **Goal:** Ensure that stormwater reuse is allowed and encouraged for non-potable uses. **Why:** Stormwater reuse is important for dense, urban areas with limited spaces for vegetated green infrastructure practices.	**Adopt Plans/Educate:** • Local government provides information brochures/manual for homeowners describing acceptable rain water harvesting techniques.	1		
	Remove Barriers: • Local development, building, and plumbing codes updated to allow reuse of stormwater for non-potable purposes.	1		
	Adopt Incentives: • Reduce stormwater management facility requirements for developments employing comprehensive rain water harvesting.	1		
	Enact Regulations: • Require developments to adopt rain water harvesting techniques as element of stormwater management plans.	1		

The Green Factors

SEATTLE×*green factor*

SEATTLE GREEN FACTOR:

- Maximizes vegetation potential in rights-of-way
- Rewards layering of plant material
- Rewards tree preservation
- Rewards larger species of trees
- Rewards low water use
- Rewards landscapes visible to passersby
- Provides flexibility for developer to meet the code



Bonus +0.1: For drought tolerant landscapes and for landscapes visible from the right-of-way.

Questions

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http://picasaweb.google.com/buildgreeninfrastructure

Integrated Water Management Rainwater Harvesting

EPA Webcast
Managing Wet Weather
with Green Infrastructure
March 24, 2009

Chris Kloss
Low Impact Development Center
www.lowimpactdevelopment.org

The Low Impact Development Center, Inc.

U.S. Water Supply

- Universal access to potable water supplies.
- World's highest per capita use – approximately twice that of Europe.
- Cost of water is among the lowest in the world.
  - 0.07¢ - 0.4¢ per gallon ⇨ 70¢ - $4 per 1,000 gallons
  - Average cost nationally approximately $2 per 1,000 gallons

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U.S. Water Supply (cont.)

- Population growth & development increasing demand.
- Sustained droughts in Southeast & Southwest.
- Climate change may decrease snowpack and introduce drier climate.
- Water managers in 36 states anticipate water shortages.

Prettyboy Reservoir, Maryland during 2002 drought.
Photo courtesy of National Weather Service.

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Domestic Water Use

Typical Domestic Daily per Capita Water Use.

Use	Gallons per Capita	% of Daily Total
Potable indoor uses		
▪ Showers	11.6	7.0%
▪ Dishwashers	1.0	0.6%
▪ Baths	1.2	0.8%
▪ Faucets	10.9	6.6%
▪ Other uses, leaks	11.1	6.7%
Subtotal	**35.8**	**21.7%**
Non-potable indoor uses		
▪ Clothes washers	15.0	9.1%
▪ Toilets	18.5	11.2%
Subtotal	**33.5**	**20.3%**
Outdoor uses	**95.7**	**58.0%**

American Waterworks Association Research Foundation (AWWARF), *Residential End Uses of Water*, Denver, CO, AWWARF, 1999.

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Commercial Water Use

Typical Daily Water Use for Office Buildings and Hotels.

Use	Office Buildings % of Daily Total	Hotels % of Daily Total
Potable indoor uses		
▪ Showers	---	27%
▪ Faucets	1%	1%
▪ Kitchen	3%	10%
▪ Other uses	10%	19%
Subtotal	**14%**	**57%**
Non-potable indoor uses		
▪ Toilets/urinals	25%	9%
▪ Laundry	---	14%
▪ Cooling	23%	10%
Subtotal	**48%**	**33%**
Outdoor uses	**38%**	**10%**

Pacific Institute, *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, November 2003.

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Current Conditions

- Non-potable uses constitute a large percentage of demand.
- Disparity between “high-quality” water supply and large percentage of “low-quality” demand.
- Inefficiencies propagated by inadequate pricing and continuation of familiar practices.
- Building and plumbing codes often necessitate potable water use throughout a building or residence.

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Water Pricing

- Inexpensive cost of water creates little incentive for conservation.
- GAO found insufficient funding in 29% of water utilities to cover cost of providing service.
- Water demand is relatively inelastic – increased prices have limited effect on use but can encourage supply substitution.
- Full cost pricing is one of EPA's four pillars of sustainable infrastructure – ideally accounts for externalities in addition to capital and O&M costs.

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Rainwater Harvesting

- Collecting roof rainwater in rain barrels or cisterns for later reuse.
- Residential and commercial applications.
- Ideal for outdoor and non-potable indoor uses.
- Can be used for potable uses with proper treatment.

Chicago Center for Green Technology.
Photo courtesy of Farr Associates.

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Rainwater Harvesting Benefits

- Provides inexpensive supply of water.
- Augments drinking water supplies.
- Reduces stormwater runoff and pollution.
- Reduces erosion in urban environments.
- Provides water that needs little treatment for irrigation or non-potable indoor uses.
- Helps reduce peak summer demands.
- Helps introduce demand management for drinking water systems.

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Water Supply & Energy Demand

Estimated Energy Consumption for Water Treatment and Distribution.

Activity	**Energy Consumption kWh/MG**		
	Northern CA	Southern CA	National Avg.
Supply and conveyance	150	8,900	---
Water Treatment	100	100	---
Distribution	1,200	1,200	---
Total	**1,450**	**10,200**	**250**

California Energy Commission, *California Water – Energy Issues*, Public Interest Energy Research Program, Presented at the Western Region Energy – Water Needs Assessment Workshop, Salt Lake City, Utah, January 10, 2006.

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Water Supply & Energy Demand (cont.)

- Reducing water demand 10% could save 293 billion kWh of electricity each year.
- Energy costs account for 80% of typical water bill.
- Energy accounts for 1/3 of utility operating costs.
- 7 to 8% of national energy consumption tied to treating and distributing water.

Michael Nicklas, *Rainwater*, High Performance Buildings, Summer 2008.

G. Tracy Mehan, *Energy, Climate Change, and Sustainable Water Management*, Environment Reporter, 2007.

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Water Supply & CO_2 Emissions

Carbon Dioxide Emissions from Electric Power Generation.

Fuel Type	CO_2 Output Rate Pounds CO_2/kWh	CO_2 Output per MG Water Delivered (x 1,450 kWh) Northern CA	CO_2 Output per MG Water Delivered (x 10,200 kWh) Southern CA	CO_2 Output per MG Water Delivered (x 250 kWh) National Avg.
Coal	2.117	3,070 lbs	21,600 lbs	530 lbs
Petroleum	1.915	2,775 lbs	19,500 lbs	480 lbs
Natural gas	1.314	1,905 lbs	13,400 lbs	330 lbs

U.S. Department of Energy and U.S. EPA, *Carbon Dioxide Emissions from the Generation of Electric Power in the United States*, July 2000.

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Los Angeles Water Supply

- Demand of 500 MGD.
- Approximately 445 MGD supplied by Los Angeles, California, and Colorado River Aqueducts.
- 4.6 million kWh are used daily to deliver water via aqueducts.
- If natural gas is fuel for power plants – 3,000 tons of CO_2 emitted each day for water delivery.

California Aqueduct.

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King Street Center – Seattle, WA Water Conservation

Rainwater Harvesting

- Over 16,000 gallons of storage at 327,000 ft^2 King Street Center used for toilets and irrigation. Provides 60% (1.4 million gallons) of toilet flushing water annually.
- CO_2 reduction of 700 lbs.

King Street Center.

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The Solaire - Battery Park City, NY

- Required 2.4 inches of rainwater retention.
- 10,000 gallon cistern in basement.
- Rainwater treated with sand filter and chlorine prior to use for irrigating two green roofs.
- Treated and recycled blackwater used for toilet flushing and make-up water.
- 50% decrease in potable water use.

The Solaire. The first green U.S. residential high rise.

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Chesapeake Bay Foundation HQ

- Rainwater collected in 3 exposed cisterns.
- Building uses composting toilets.
- Rainwater treated with sand filter, chlorine, static mixer, and carbon filter.
- Reused water used for bathroom and mop sinks, gear washing, irrigation, fire suppression, and laundry.
- 90% decrease in potable water use.
- 73% of water used in building from cistern system.

Philip Merrill Building cisterns. *Photo: Chesapeake Bay Foundation.*

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Stephen Epler Hall – Portland, OR

- 62,500 sf mixed-use student housing.
- Rainwater used for visual aesthetic – roof runoff is diverted to river rock "splash blocks" in public plaza and then to planter boxes.
- Effluent from planter boxes collected in underground cisterns.
- UV used to treat water prior to use for toilet flushing on first floor and irrigation.
- Saves over 100,000 gallons of potable water each year.

Epler Hall, PSU.

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NRDC – Santa Monica, CA

- Cisterns installed beneath planting beds.
- Collected rainwater is added to graywater collection system and used for toilet flushing and irrigation.
- Building uses duel-flush toilets, waterless urinals, and drought-tolerant plants.
- 60% reduction in potable water demand.

Cisterns at NRDC Santa Monica, Office

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Rainwater Harvesting Considerations

- Important to establish guidelines or codes – instances where rainwater governed by reclaimed water guidelines because of lack of adequate definitions.
- Principles of rainwater harvesting apply equally to graywater reuse – concept of matching quality of supply to quality of demand.
- Appropriate water pricing important to consider for adequate funding and resource valuation.

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Portland Code

- Defines rainwater harvesting uses for water closets, urinals, hose bibbs, and irrigation.
- Establishes treatment and material requirements for collection and plumbing systems, including labeling and pipe color.
- Defines inspection and maintenance requirements and responsibilities.

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San Francisco MOU

- Entered into in June 2008.
- Establishes responsibilities for SF Public Utilities Commission, Department of Building Inspection, and Department of Health.
- Defines uses and treatment requirements for rain barrels and cisterns.

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Codes: Know Your Audience

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Questions?

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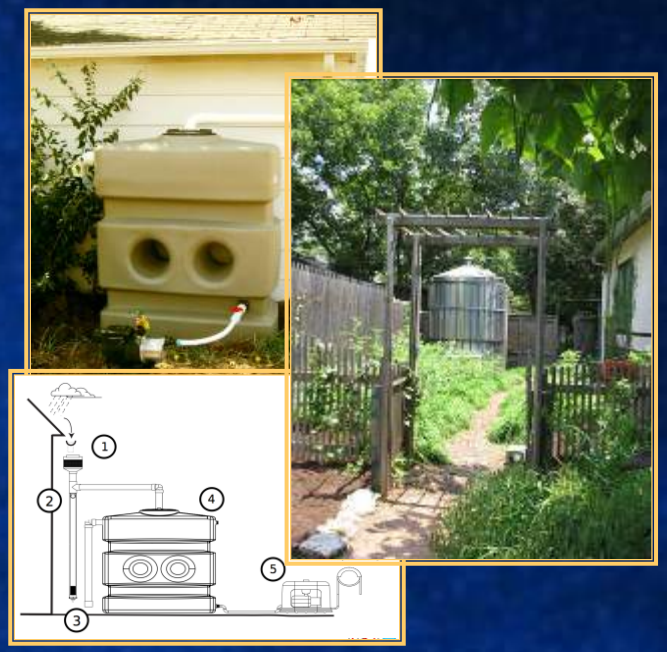
Rainwater Harvesting

Case Studies

NC Legislative Building

Raleigh, NC

Residential Systems



Bill Davis, AIA, LEED AP

progressive design + planning

Rainwater Harvesting

Environmental and Energy Benefits

- Clean Water Source
- Reduces Stormwater Impact
- Water Conservation
- Minimizes Embodied Energy of Water Delivery

Community Center, Austin, TX

Duke Smart Home, Durham, NC

Residence, Austin, TX

Sam's Club, Fayetteville, AR

Images Courtesy of *BRAE Water*, Oakboro NC

Rainwater Harvesting

Educational Value

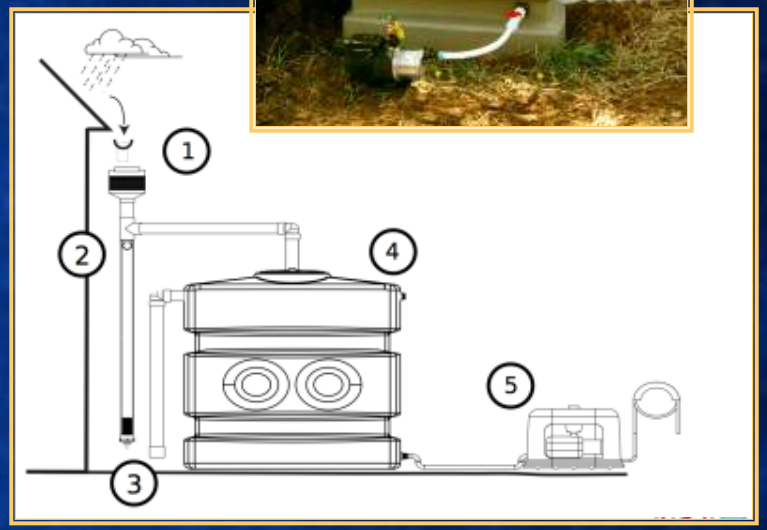
Ladybird Johnson Wildflower Center, Austin, TX

- Visual Impact of Rainwater Harvesting System Enhances Educational Value and Learning Experience of Visiting Students

Residential Installation

Simple Systems

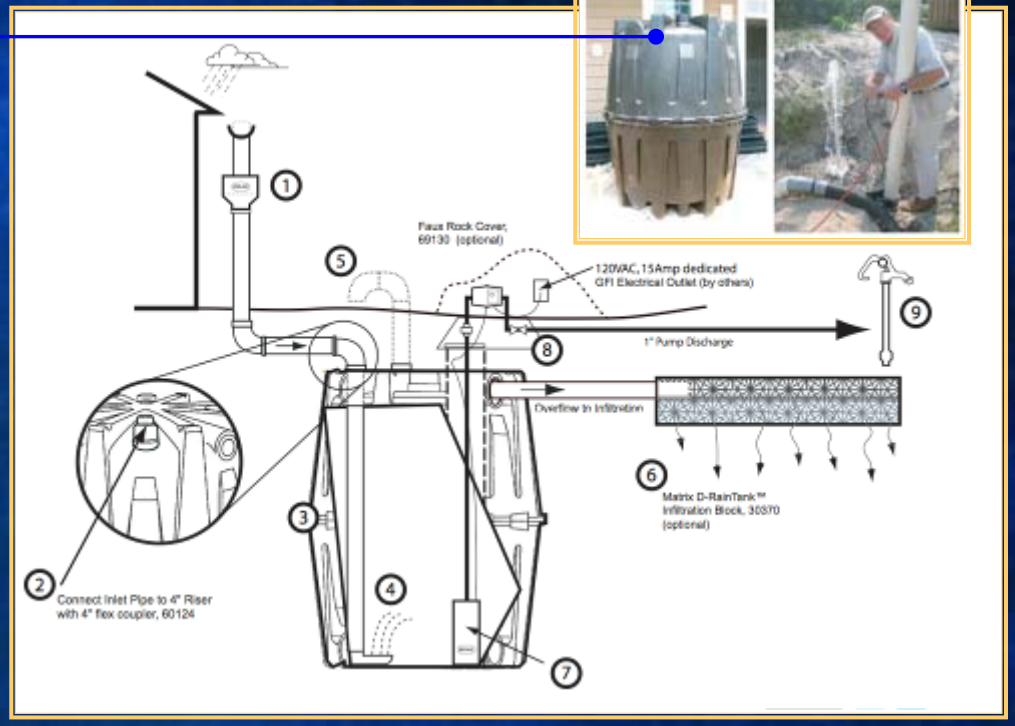
- Above Ground Storage
  1. Screen filters out leaves, branches, etc.
  2. Vertical pipe collects first flush of roof runoff
     - Pipe must be emptied after each rain event
     - Ball float within pipe to seal after first flush
  3. Overflow pipe to grade
  4. Cistern
  5. Pump and hose for gardening



Residential Installation

Simple Systems - Topsail Beach, NC

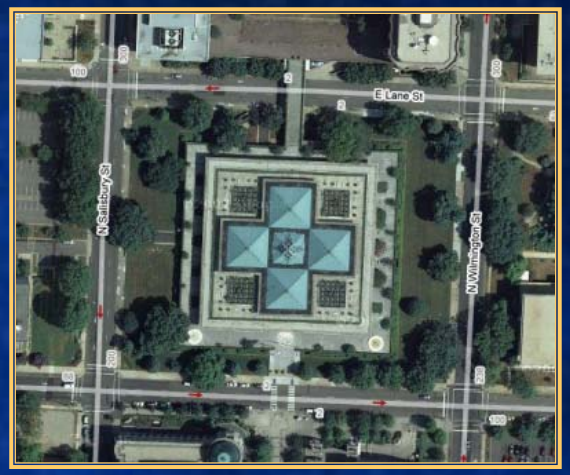
1. Downspout Filter
2. Coupling
3. 430 Gallon Cistern
4. Calmed Inlet
5. Screened Vent
6. Infiltration Overflow
7. 1/2 hp Pump
8. Valve
9. Yard Hydrant



NC Legislative Building

State Government

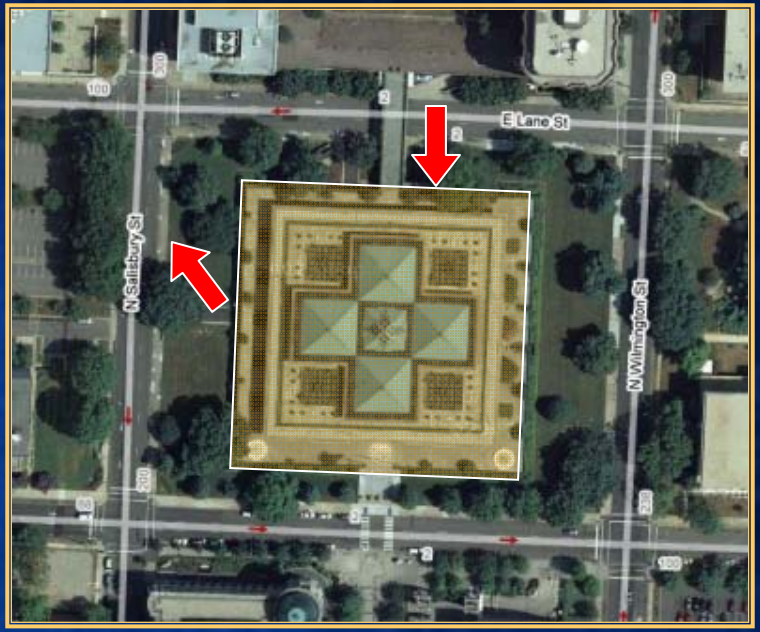
- Center of NC State Government
- Landscaped grounds and roof garden
- During drought of 2001-2002, irrigation was halted and close to $100K of plantings died at Legislative Building and Grounds
- Effort By NC General Assembly to Promote Water Conservation
- Support from NC State Energy Office



NC Legislative Building

Existing Conditions

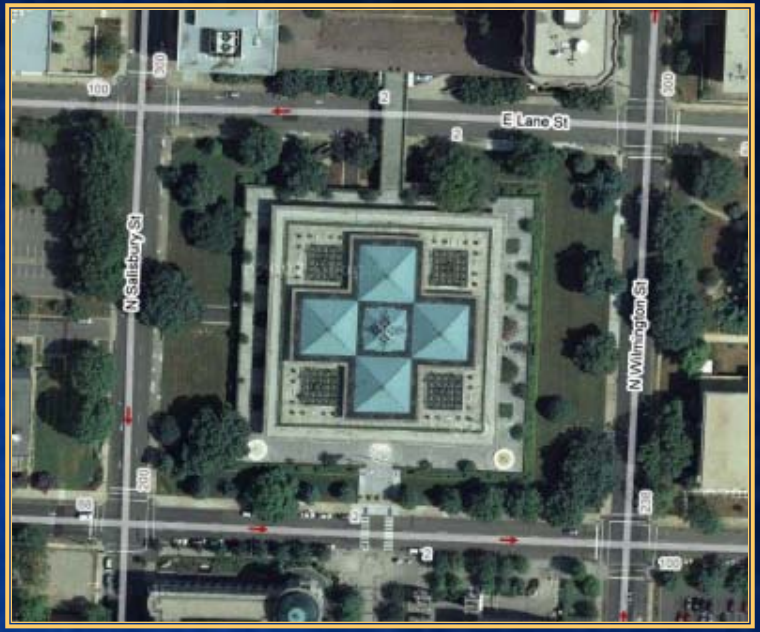
- Separate irrigation meter on north side of building
- 100,000 square feet of building and plaza area
- One 24 inch pipe for outflow to Raleigh Stormwater System
- HVAC Condensate discharge connected to Stormwater System



NC Legislative Building

Challenges to Design

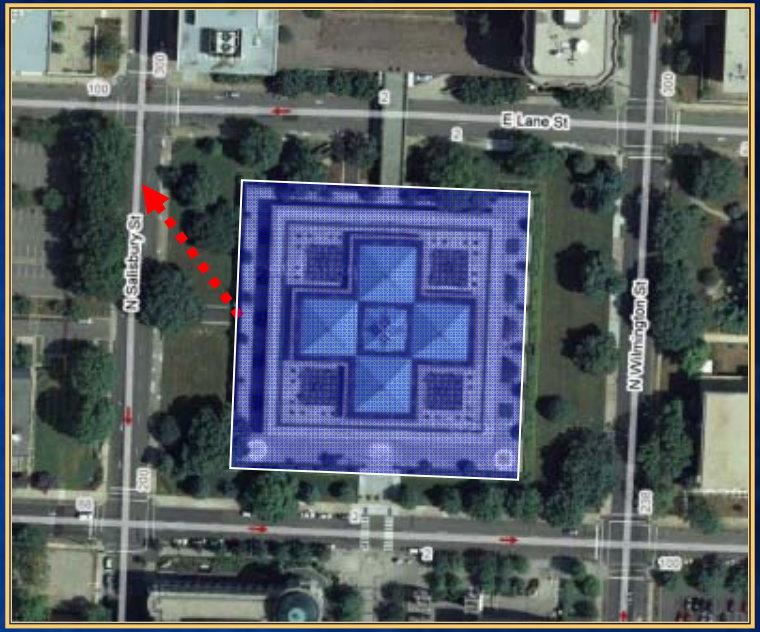
- Little available land to locate cisterns
- 24 inch Stormwater Outlet Pipe Located 12 feet below grade
- Shallow water table at about 25 feet below grade
- Landscaping, Sidewalks and Building create narrow site for deep cisterns
- Irrigation at ground level and at roof level



NC Legislative Building

Water Collection

- 100,000 square feet of roof and plaza area
- Large Volume of HVAC Condensate from building is connected to stormwater system
- One 24 inch Stormwater outlet pipe for entire building impervious surface



NC Legislative Building

Water Collection - Pop Quiz

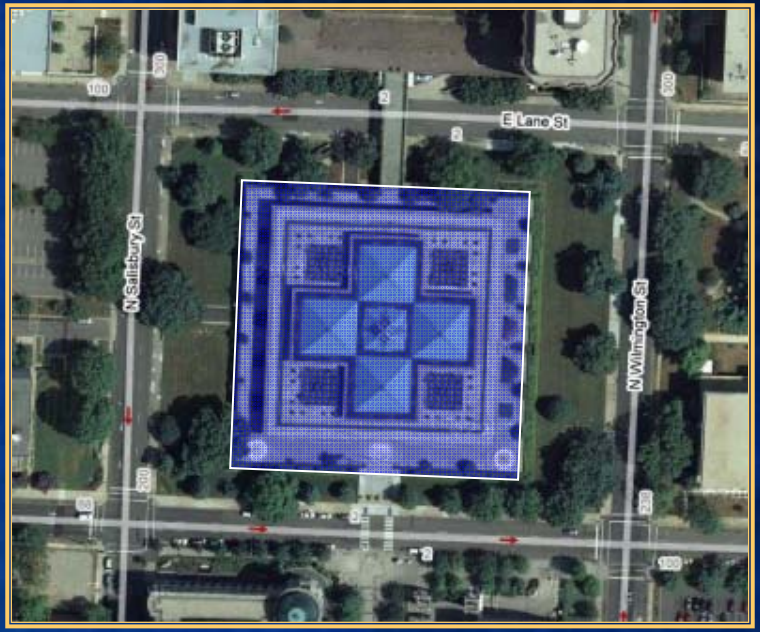
Approximately how much water can be collected from 100,000 square feet of roof area, assuming 47 inches of annual rainfall?

A. 800,000 gallons

B. 1,150,000 gallons

C. 2,300,000 gallons

D. 2,900,000 gallons



NC Legislative Building

Water Collection - Volume Calculations

- 100,000sf x 47in (3.93 ft) = ***391,667*** cubic feet
- 391,667cuft x 7.48 gal/cuft = ***2,929,669*** gal
- Assuming ***15-20%*** loss to evaporation
- 2,929,669gal x 80% = ***2,343,735*** gallons/yr

- Additionally, engineering calculations showed approximately ***700,000*** gallons yearly in HVAC condensate
- Total Estimated Collection: ***3,000,000*** gallons/yr

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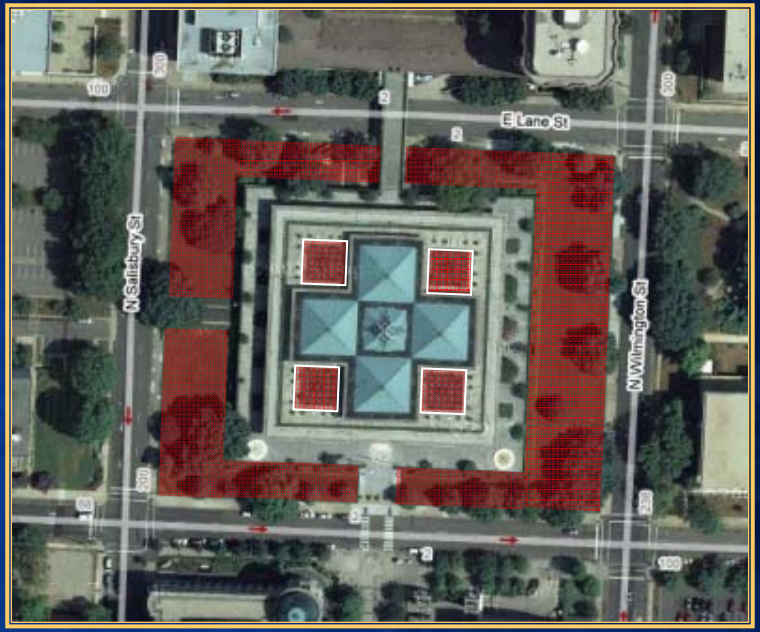
Landscape Irrigation Demand

- Lawn Areas
- Foundation Planting Beds
- Roof Gardens
- Interior Fountains
- Exterior Fountains
- Off-Site Planters
  - Watering by Tank Trucks to be filled with collected rainwater



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Cistern Design

- NOAA Rainfall Data/Weather Data evaluated for average monthly rainfall amounts, runoff volume and condensate volume
- Average frequency and volume of individual rain events evaluated to determine days of irrigation and estimated daily tank volume and overflow
- Historical data evaluated for irrigation demand
- Evapotranspiration (ET) evaluated for irrigation demand
- Weekly Water Balance created to evaluate supply, demand and overflow

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Cistern Design

- Cistern Types Evaluated:
  - Modular Matrix w/Pond Liner Wrap
  - Polyethylene
  - Fiberglass
  - Precast Concrete
- Three 18,000 gallon precast concrete cisterns chosen for:
  - Durability
  - Easily accessed with conventional manholes/risers
  - High water table - potential for “float” if tank is empty
  - Cost: ≈ $40,000
    - Three 10’x20’x12’ deep Cisterns
    - One 1,800 gallon grease interceptor for Sediment Filter
    - Manholes and risers to access all precast tanks

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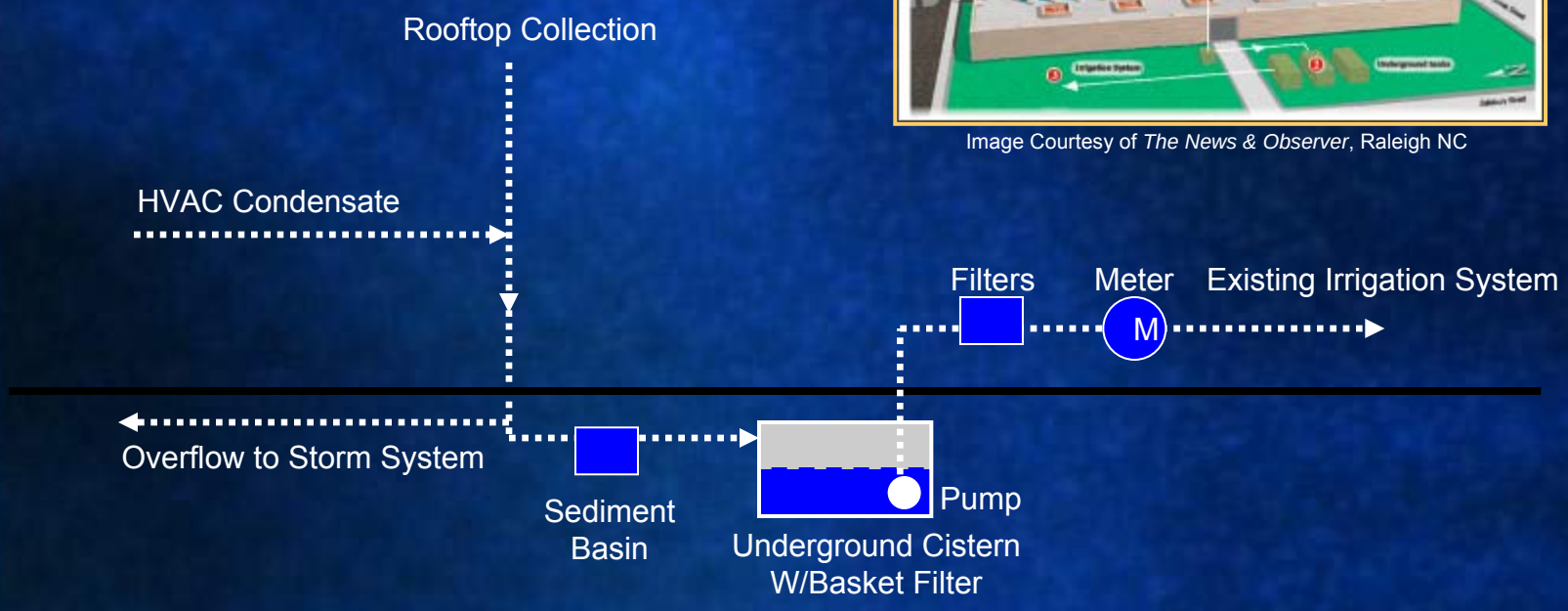
System Schematic

Image Courtesy of *The News & Observer*, Raleigh NC



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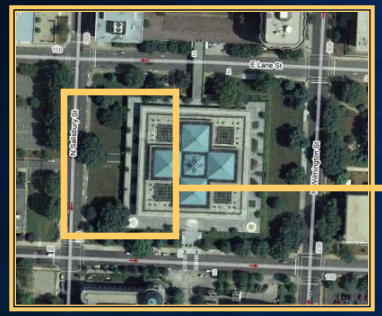
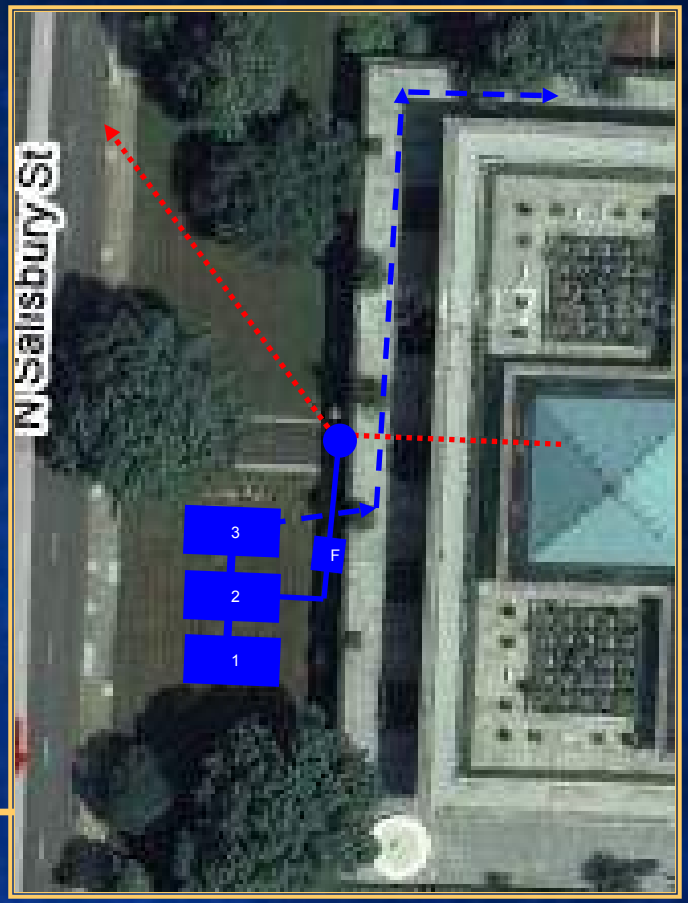
System Layout

- Tanks Located on West Lawn
- New Manhole Used to Divert Stormwater to Filter Tank (F) and Cisterns 1, 2 and 3
- Also Used for Overflow for System
- Submersible Pump in Tank 3 Pumps Water to Filter Room and Irrigation Meter
- Connection to Raleigh City water remains in case of emergency





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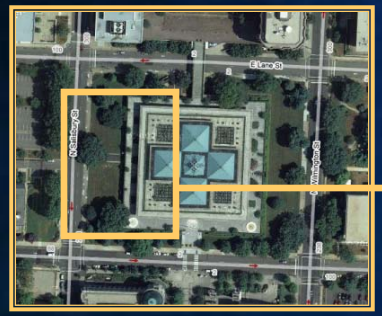
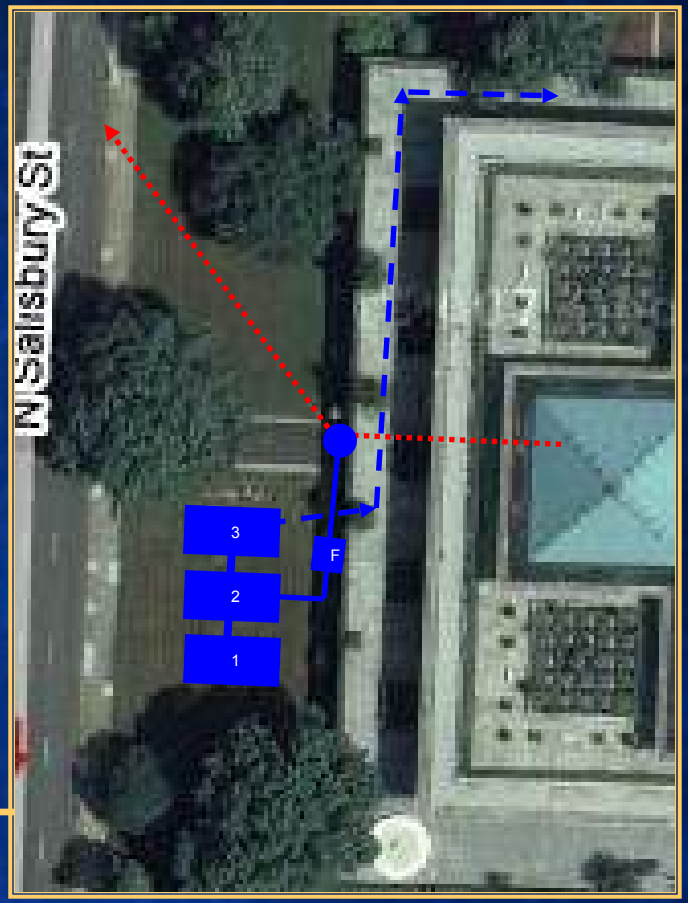
System Layout

- Hose bibb connection and automatic pump control located in loading dock area for tank trucks
- Pump and flow meter located in Groundskeeper's storage room for easy access and maintenance
- Basket filter at (F) can be easily checked and lifted out for cleaning
- Submersible pump on rail system for removal/replacement if req'd





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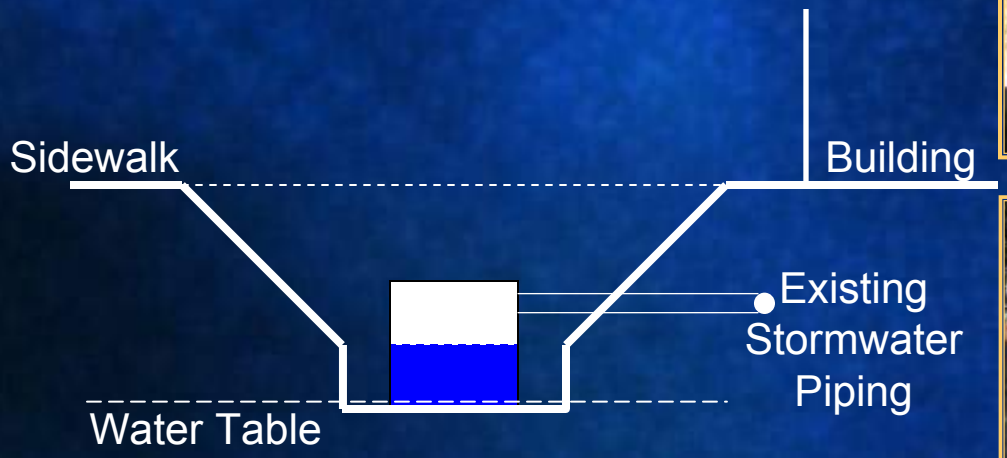
Construction

- All available land was used to slope back excavation
- Gravel placed at bottom for even placement of tanks



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Construction

- Connection pipes were placed inside tank for easier installation
- All precast tanks and risers were placed during a three-day weekend to minimize traffic congestion
- Delivery trucks were coordinated with crane for minimal delay between placement of pieces

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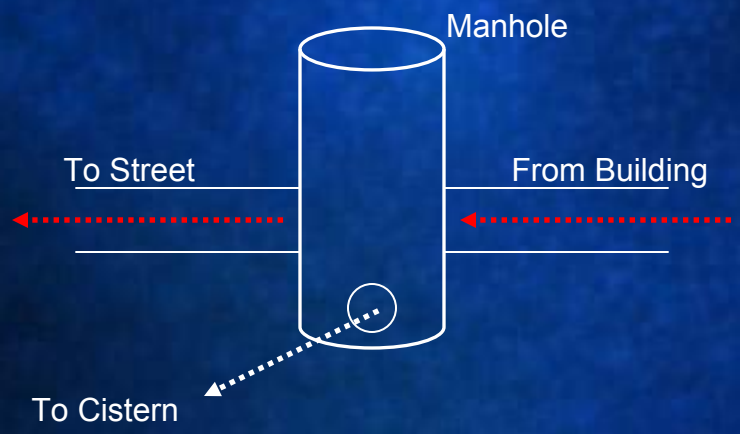
Construction

- After placement of precast cisterns, site was graded and stormwater piping was connected
- New manhole is used to provide overflow back through new piping



- If cistern fills, manhole fills to higher invert elevation and water flows to Stormwater Sytem

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Controls and Monitoring

- System Controls
  - New water meter and control system uses water from cistern when available
  - Fail-safe Controls switch to Raleigh City water if cistern is low
  - Float switches operate pump
- Level and Flow Monitoring
  - Water flow meter and level sensor placed within system to allow remote monitoring from Groundskeeper's desktop
  - System is able to communicate through General Assembly Intranet to allow data collection and connection to a future educational kiosk at the Legislative Building

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System Costs

- Cisterns and precast concrete: ≈$40,000
- Balance of System: ≈$310,000
- Total System Cost: **≈$350,000**

- Reasons for High Costs:
  - Deep pits for placement of tanks - shoring required
  - New stormwater piping was deep
  - Construction scheduled to accommodate NC Legislature

- Benefits of the System:
  - Zero water use from City of Raleigh since system has been fully installed (2-3 years)
  - Educational Benefit to building visitors (≈60,000/yr)
  - Reduced impact on Raleigh Stormwater System
  - Example of State Government supporting environmental stewardship

Contacts and Websites

- NC General Assembly
  - http://www.ncga.state.nc.us/ncgainfo/cistern/cisternhome.html
- Bill Davis, AIA, LEED AP
  - Progressive Design + Planning
  - www.progressivedp.com
- American Rainwater Collection Systems Assn.
  - www.arcsa.org
- Shawn Hatley
  - BRAE Rain Harvesting Systems
  - www.braewater.com

Questions?

Participation Certificate

- If you would like to obtain participation certificates for multiple attendees, click the link below
- You can type each of the attendees names in and print the certificates

http://www.epa.gov/npdes/webcasts/certificate/gi_plans.pdf