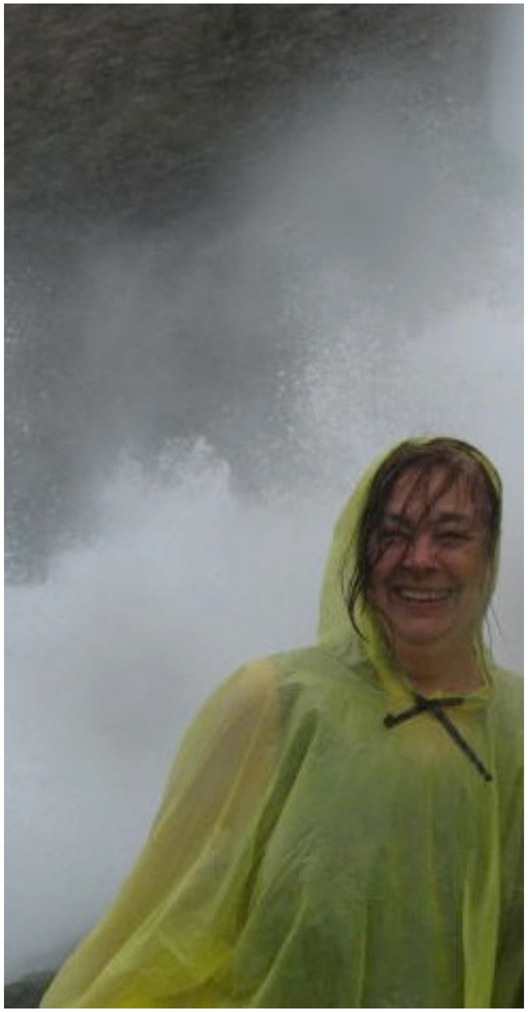
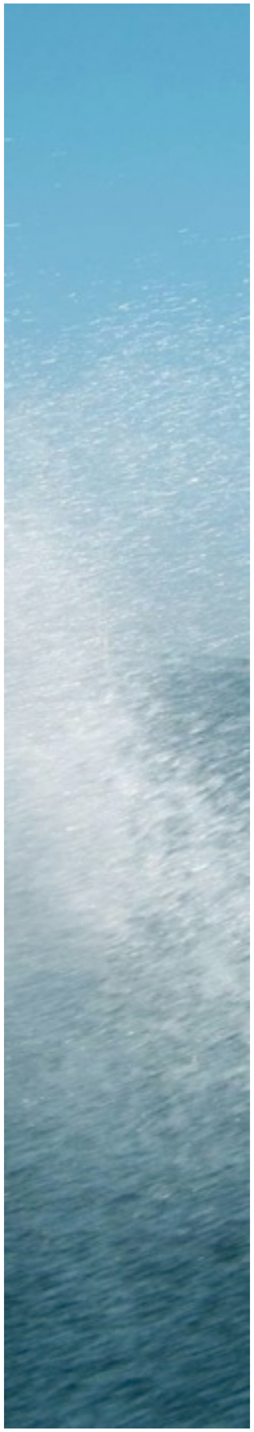
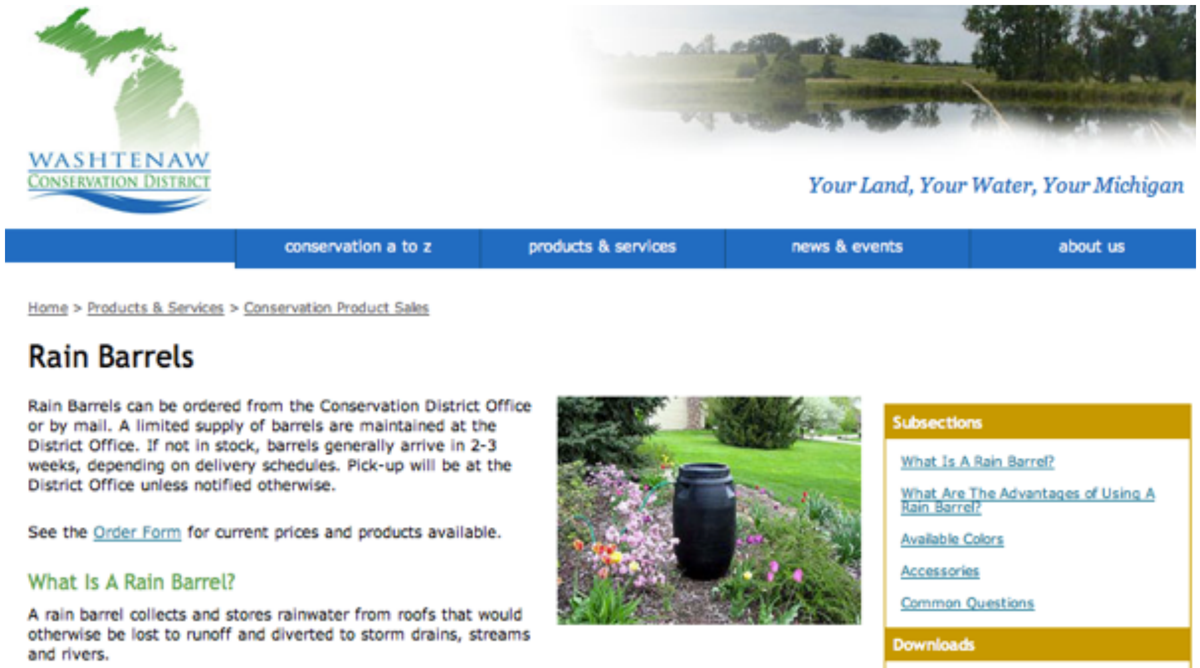




Resilient Rainwater | Collection

Designing Integrated Rainwater Systems For Use Inside Buildings.

Celeste Allen Novak Architect FAIA, LEED AP



WASHTENAW
CONSERVATION DISTRICT

Your Land, Your Water, Your Michigan

conservation a to z | products & services | news & events | about us

Home > Products & Services > Conservation Product Sales

Rain Barrels

Rain Barrels can be ordered from the Conservation District Office or by mail. A limited supply of barrels are maintained at the District Office. If not in stock, barrels generally arrive in 2-3 weeks, depending on delivery schedules. Pick-up will be at the District Office unless notified otherwise.

See the Order Form for current prices and products available.

What Is A Rain Barrel?

A rain barrel collects and stores rainwater from roofs that would otherwise be lost to runoff and diverted to storm drains, streams and rivers.

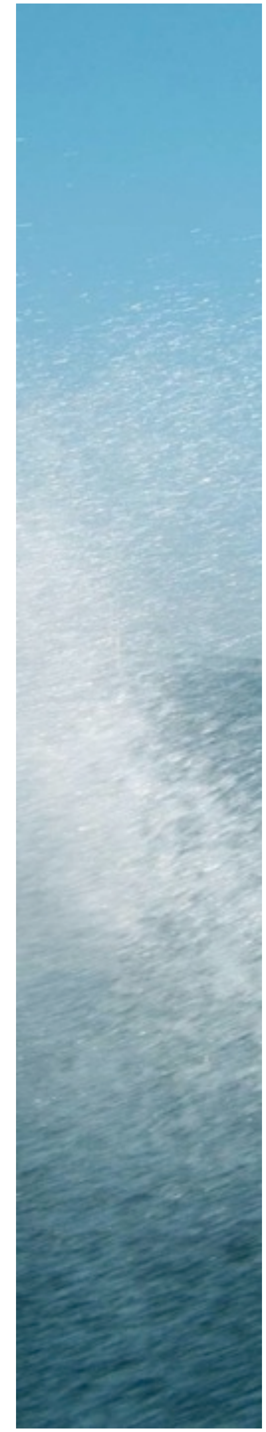
Subsections

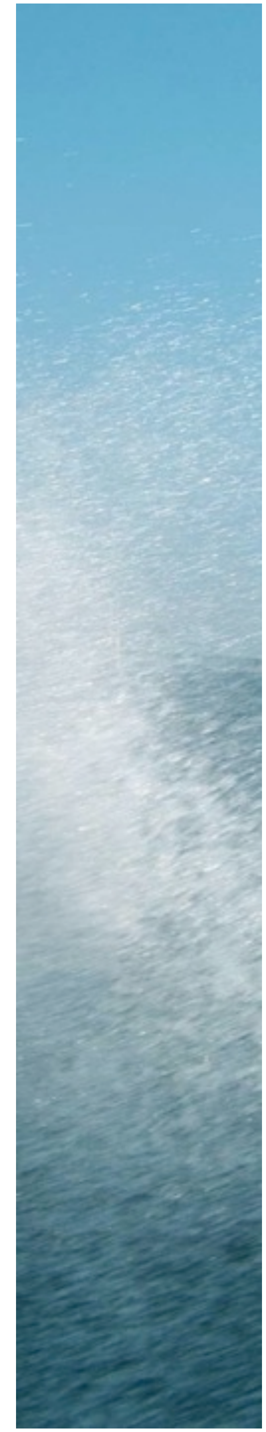
- What Is A Rain Barrel?
- What Are The Advantages of Using A Rain Barrel?
- Available Colors
- Accessories
- Common Questions

Downloads

Advantages of Using Rainwater

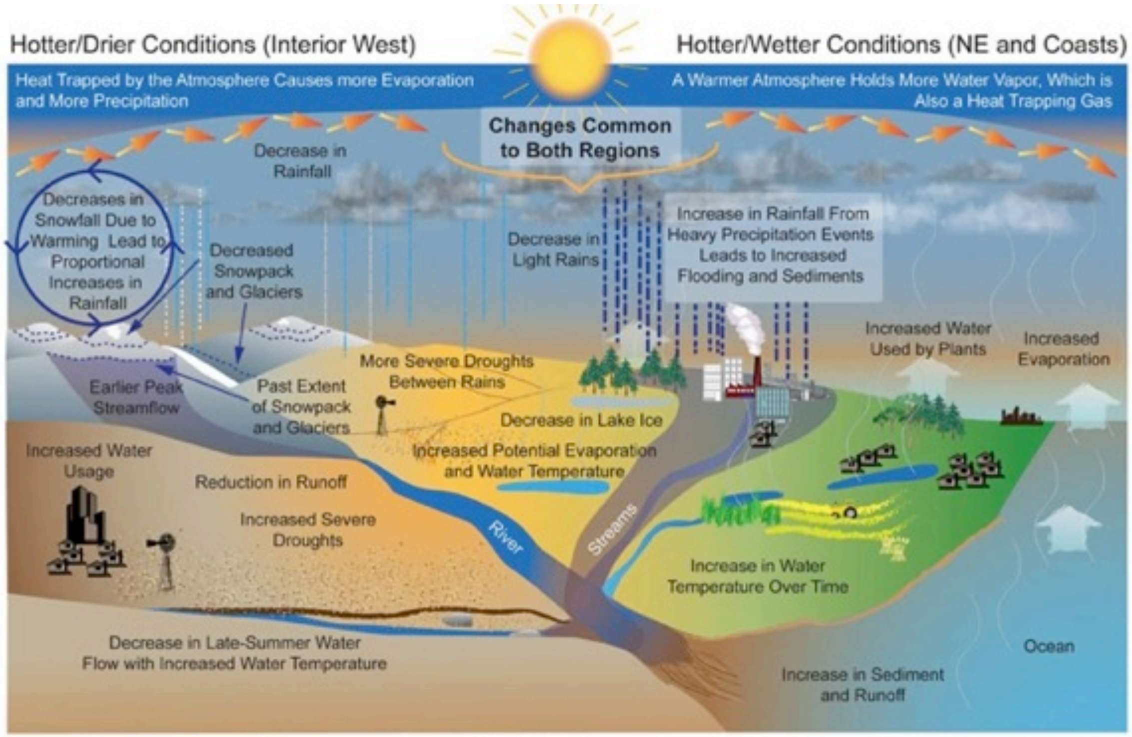
- *Saves You Money*
- *Helps Reduce Stormwater Pollution*
- *Conserves Water*
- *Better for Plants and Gardens*



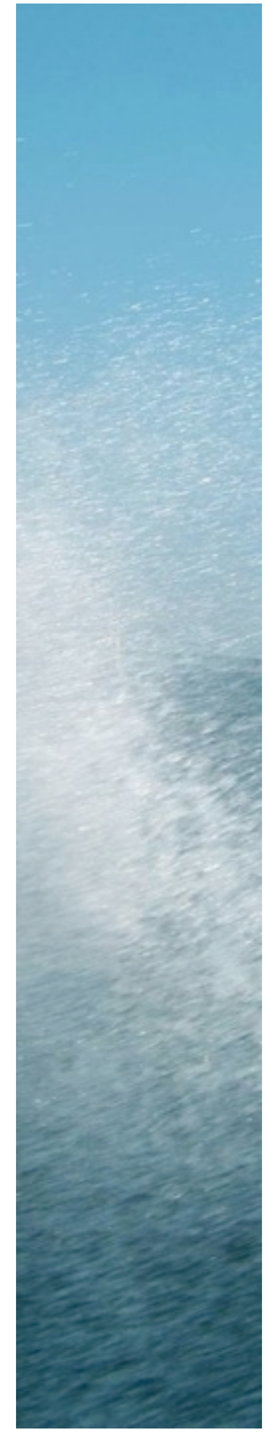


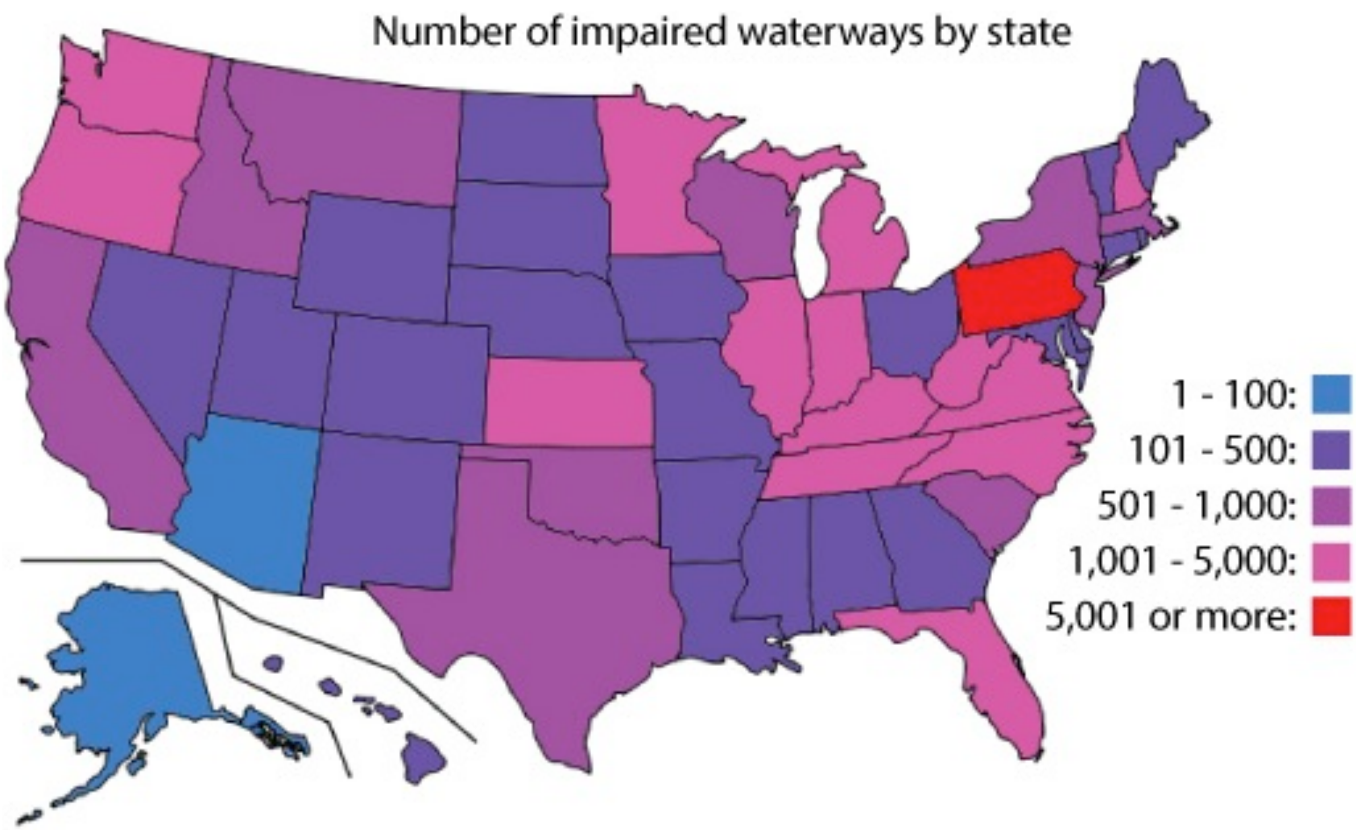
Advantages of Using Rainwater

•Pier 27 - San Francisco – 22.28 inches of rain - KMD Architects +PLA
•Toilet Flushing (33 units)
•Urinal (13 units)
•Irrigation area: Approximately 67,000 square feet



The New Hydrologic Cycle





Planning Goals – Stormwater and The Clean Water Act

"We pay to bring water in, we pay to get rid of it, and the water that is free, we pay to channel it away as fast as possible through costly stormwater infrastructures."

-Georgia Taxpayer, 2013

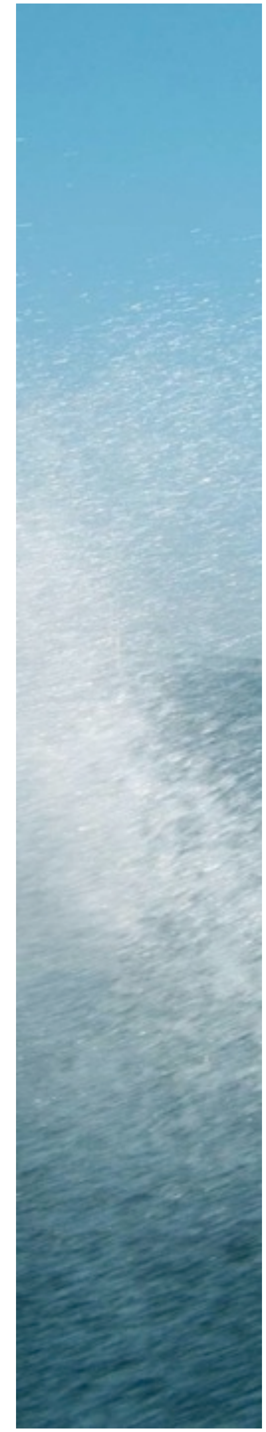
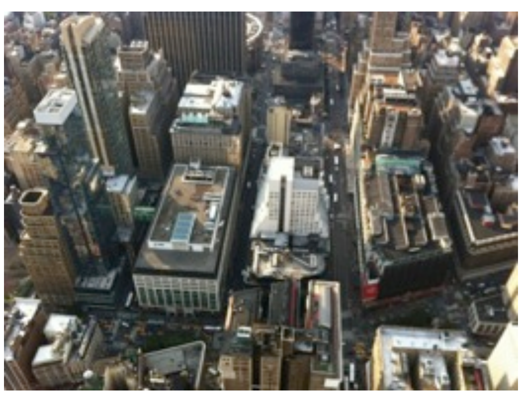


Table 2: Total Rooftop Rainfall for Eight U.S. Cities

City	Estimated 2008 Pop.	Land Area (mi²)	Acres of Residential Roof	Acres of Non-Res. Roof	Annual Rainfall (in.)	Annual Rooftop Rainfall (Billion Gal.)	Equivalent Number of People Supplied Annually	% of Pop.
Atlanta, GA	519,000	132	4,801	4,462	47.6	11.98	291,772	56.2%
Austin, TX	743,000	252	11,151	4,426	30.2	12.78	311,249	41.9%
Chicago, IL	2,837,000	227	17,288	12,099	39.0	31.10	757,493	26.7%
Denver, CO	588,000	153	7,252	4,260	14.5	4.54	110,548	18.8%
Fort Myers, FL	68,000	22	782	624	54.5	2.08	50,660	74.7%
Kansas City, MO	476,000	314	2,315	3,874	35.1	5.90	143,666	30.2%
Madison, WI	229,000	67	-	2,491	29.5	1.99	48,566	21.2%
Washington, DC	588,000	61	1,318	7,081	39.4	8.99	218,968	37.2%

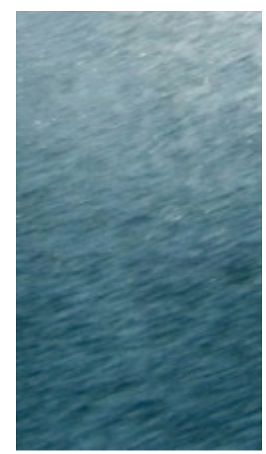
Source: Rooftop area data provided by case study cities. Rainfall data from NOAA National Climate Data Center. Population Data from Census 2000.

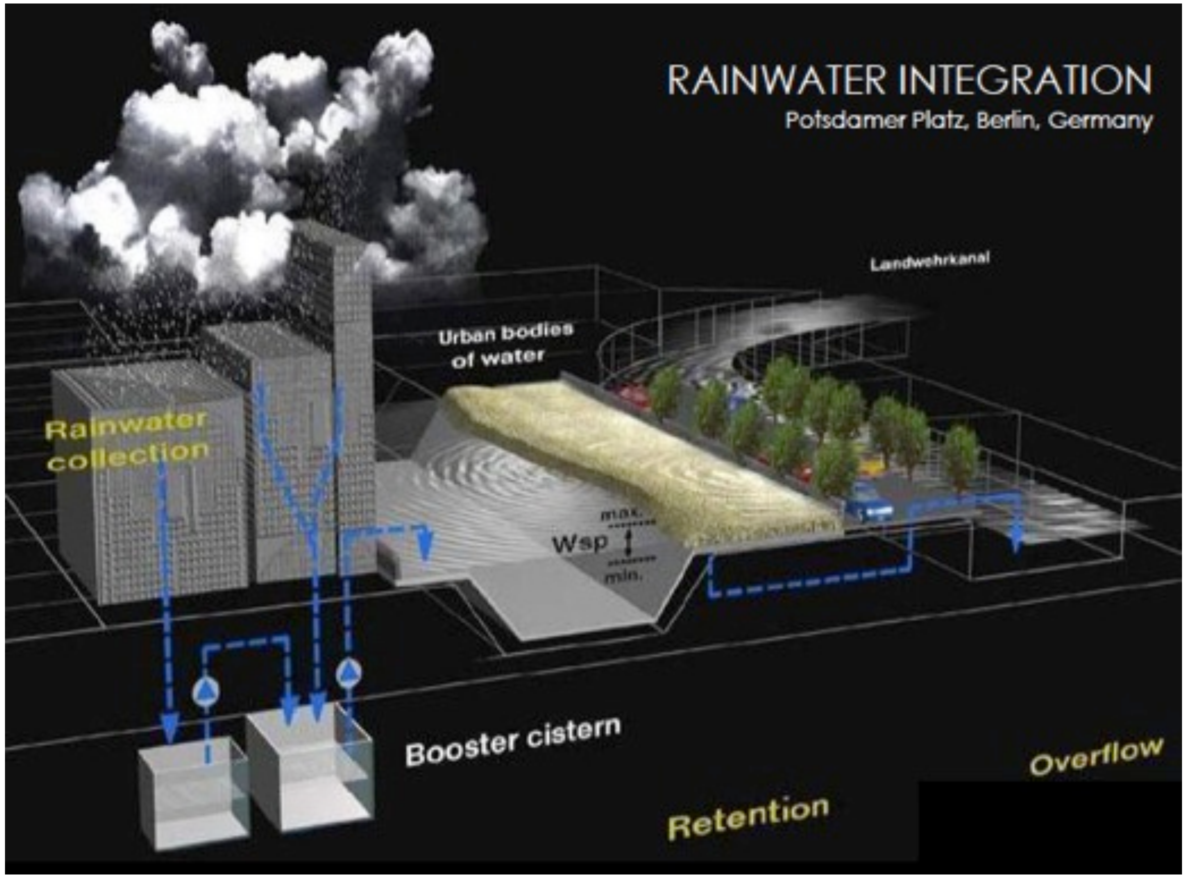


Total Rooftop Rainfall For Eight US Cities

Capturing Rainwater from Rooftops: An Efficient Water Resource Management Strategy that Increases Supply and Reduces Pollution

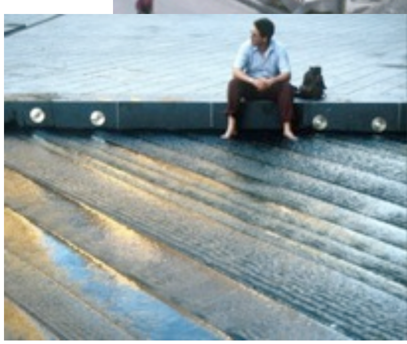
www.nrdc.org/water/files/rooftoprainwatercapture.pdf

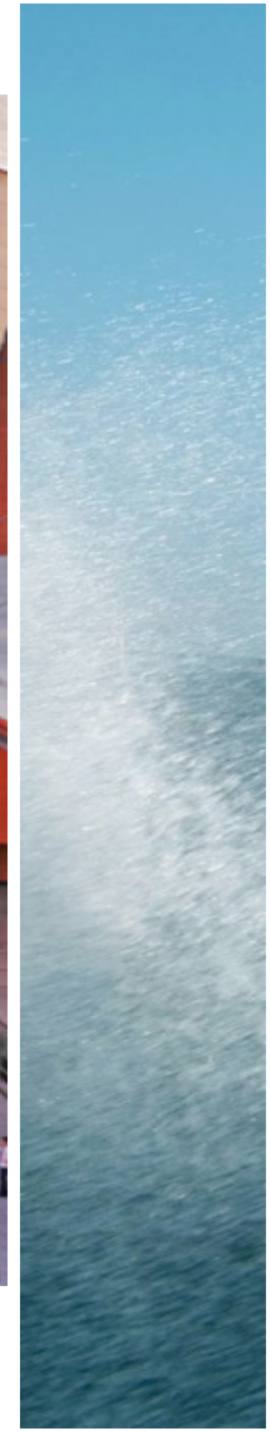


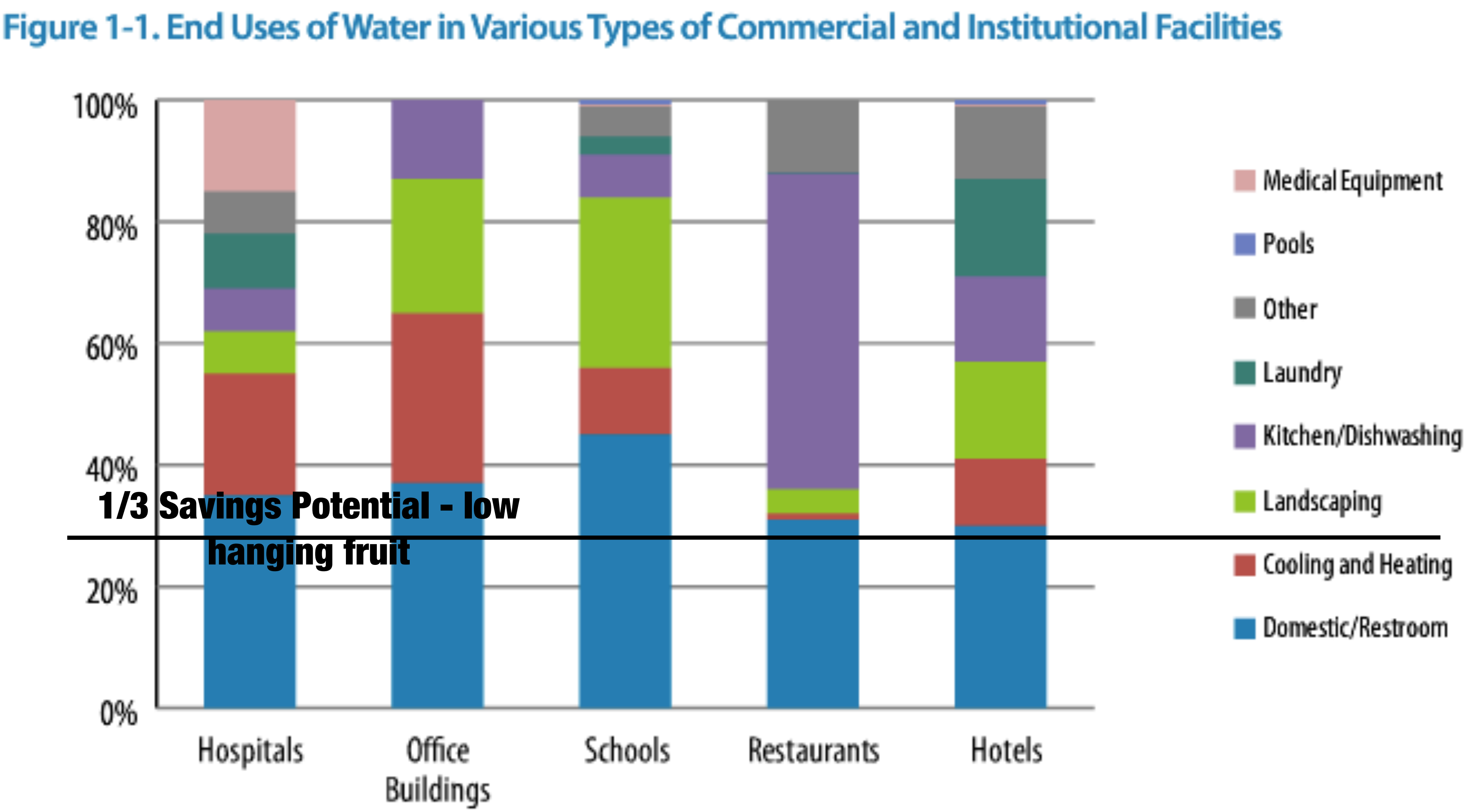


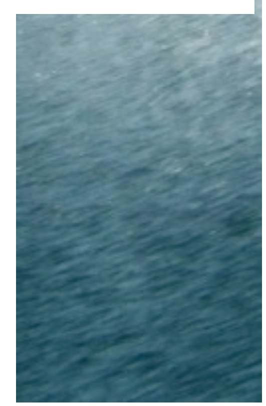
<u>USE</u> It for grey water and irrigation


MaxiMum
MaxiMum







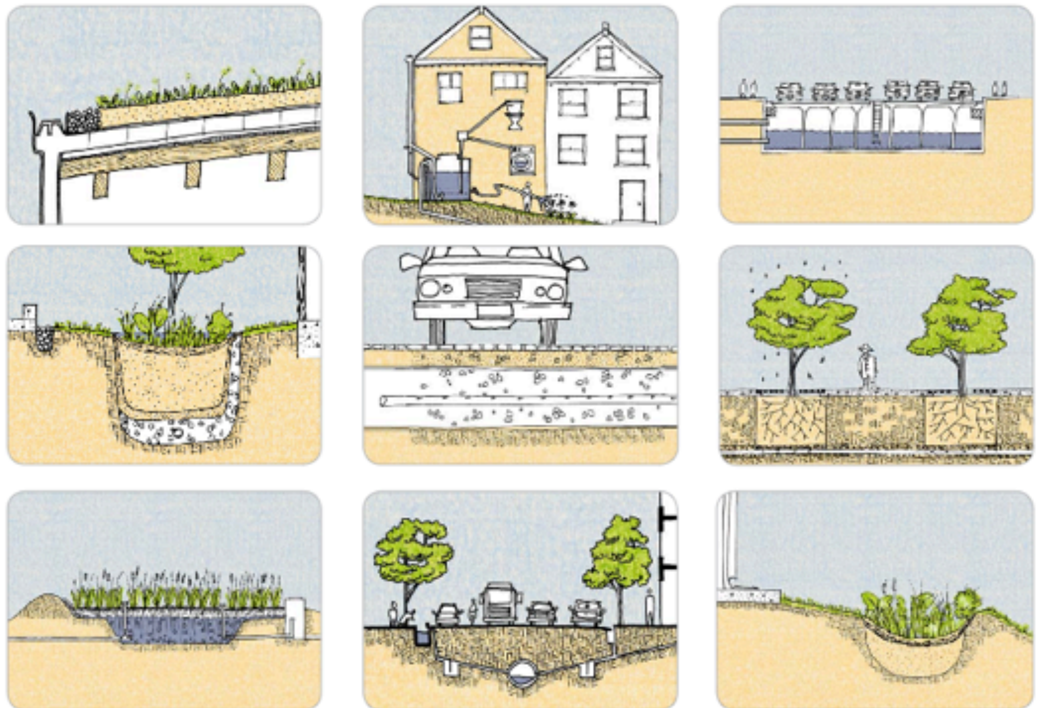


Low Hanging Fruit – Water Use in Buildings

http://www.epa.gov/watersense/commercial/docs/watersense_at_work/#/10/zoomed

States with Rainwater Legislation

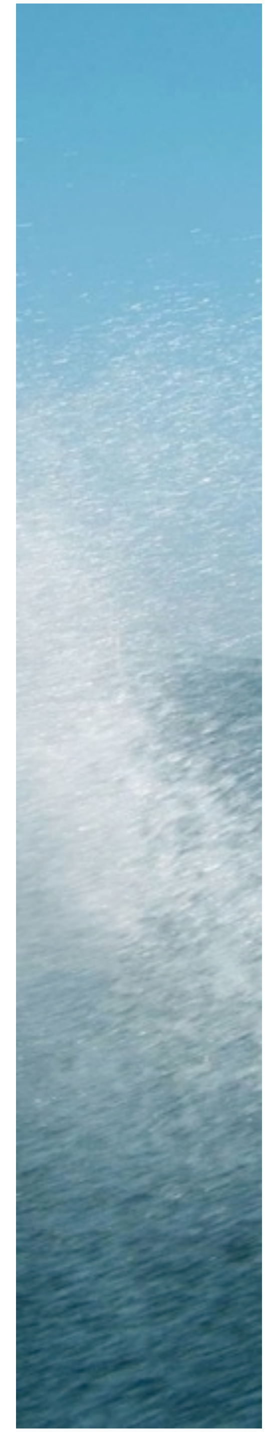
http://www.ncsl.org/research/environment-and-natural-resources/rainwater-harvesting.aspx

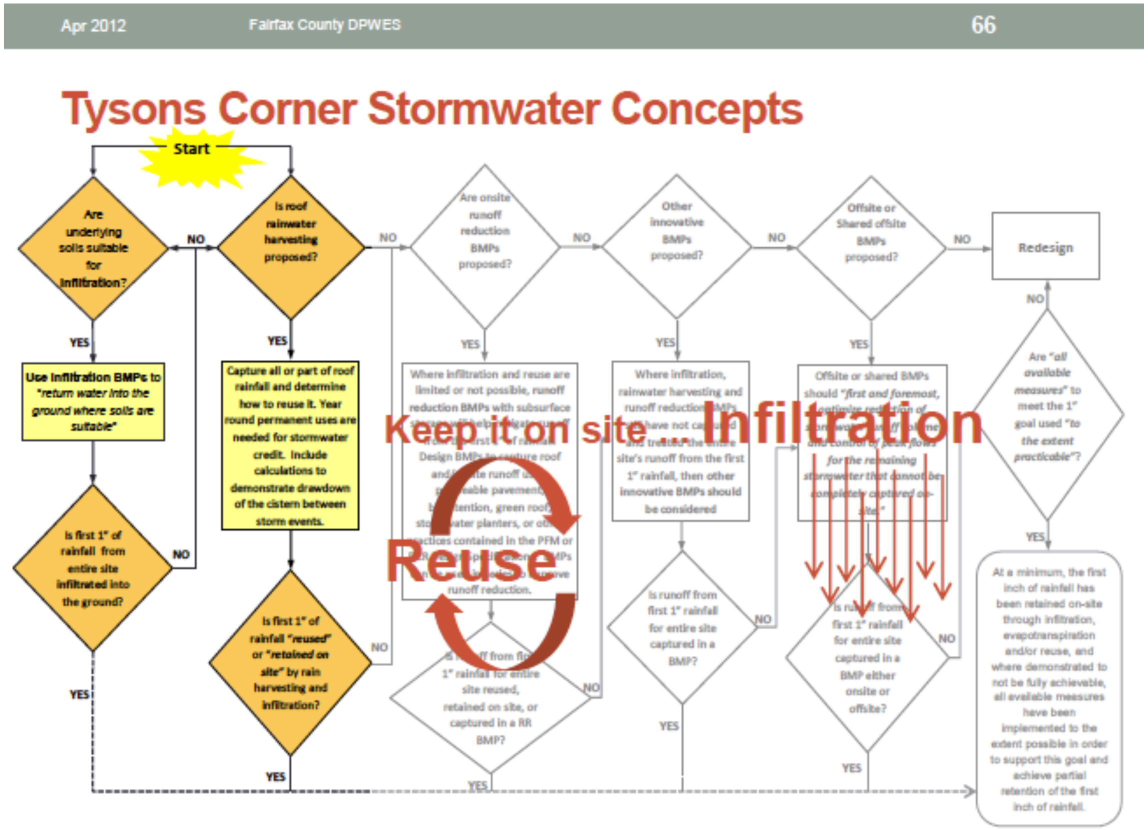


SAN FRANCISCO
stormwaterdesignguidelines

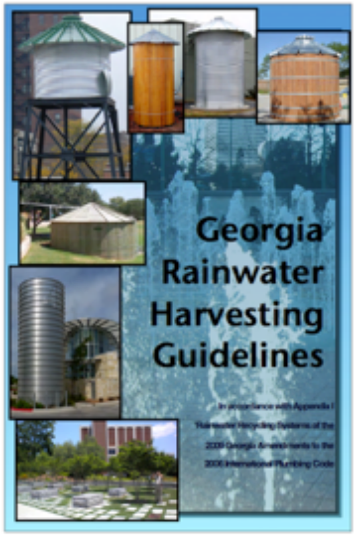
Stormwater Best Practices – San Francisco

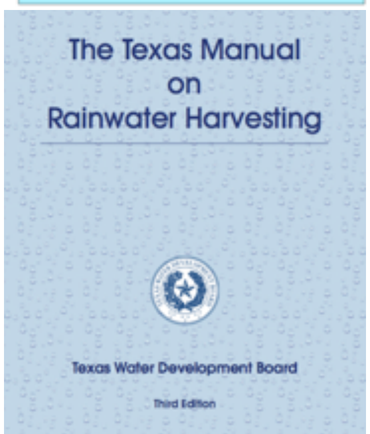
***Think of stormwater as a resource, not a waste product*!**

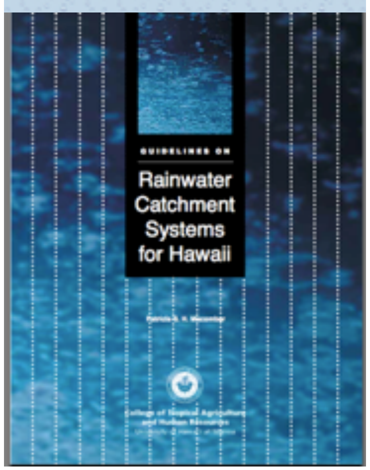


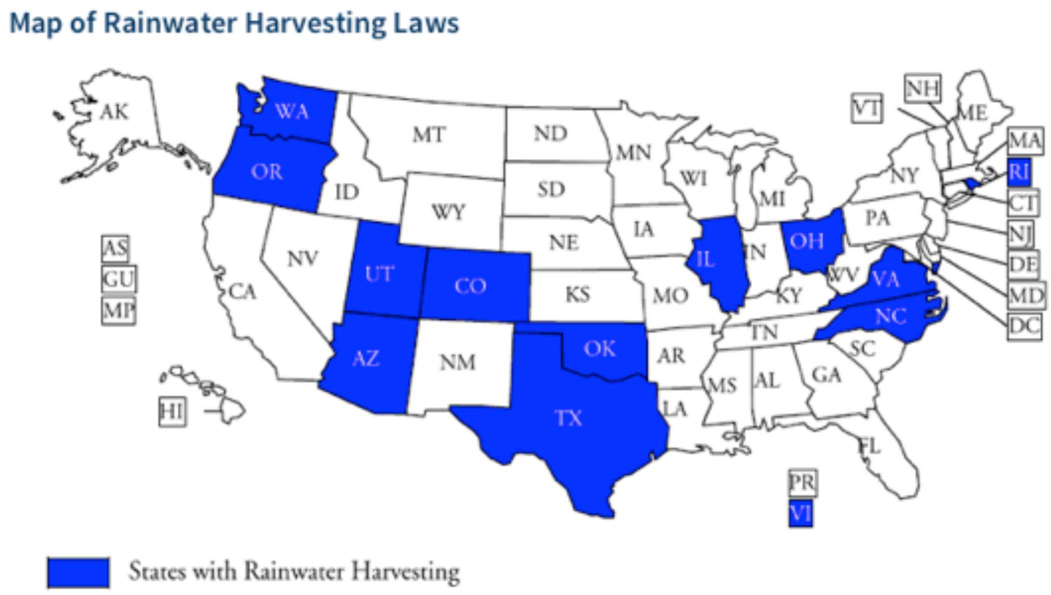


Stormwater Best Practices - Fairfax County

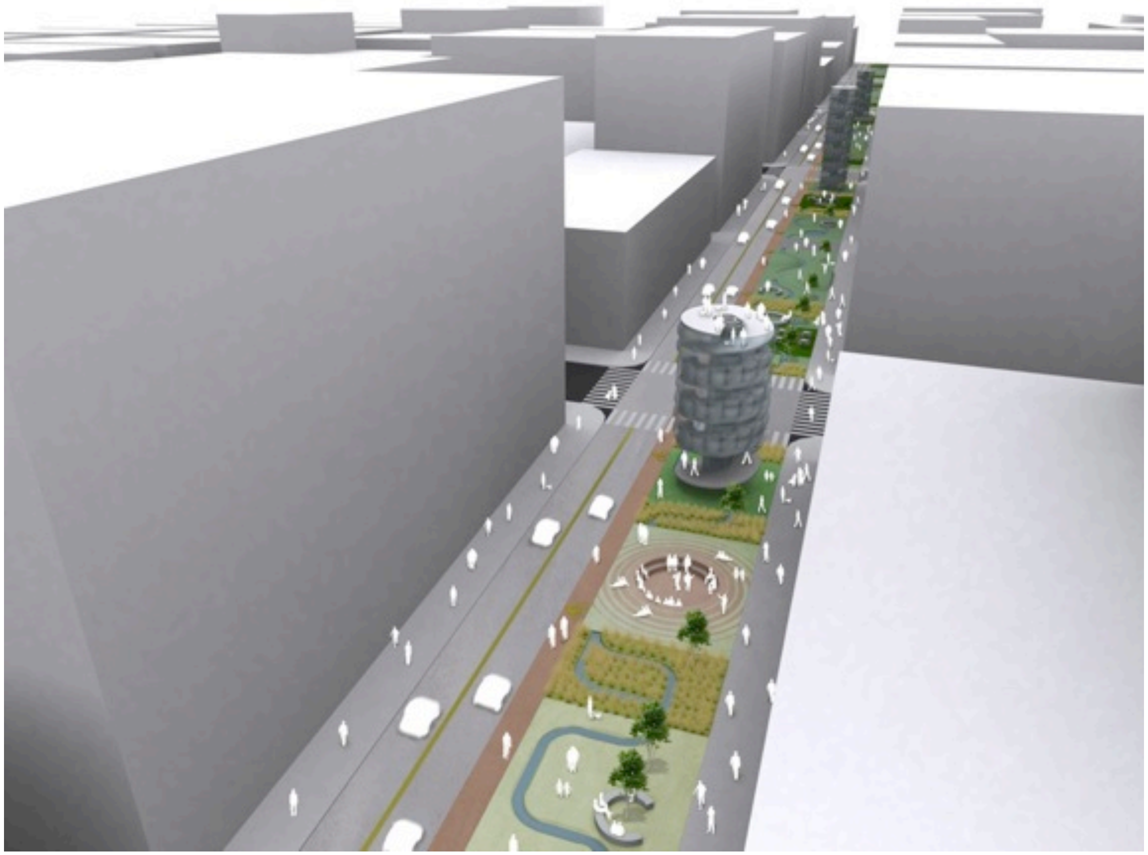






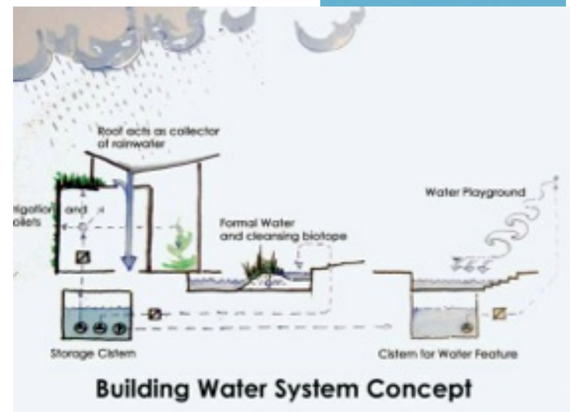


Rainwater Harvesting Guidelines By State



Eco Boulevard – Urban Lab

Growing Water: http://www.urbanlab.com/urban/ecoblvd.html



End Uses:
Toilet Flushing
Irrigation
Water Features - Fountains

QUEENS BOTANICAL GARDENS

FLUSHING, NEW YORK

COURTESY: HOK AND ATELIER DREISEITL

Todd Williams, Shooting Star Photography

End uses:

Toilet Flushing: 12 toilets and urinals

Irrigation: Approx. usage variable based on weather

METRO INTERMODAL TRANSIT CENTER

AKRON, OHIO

GPD GROUP

End Uses:

Toilet Flushing: Dual flush toilets—men = 27; women = 47; waterless urinals =14

Irrigation: Native & draught-resistant plant species used, minimal irrigation provided.

Water Feature: Rainwater waterfall

NOAA CENTER FOR WEATHER & CLIMATE PROTECTION

COLLEGE PARK, MARYLAND

COURTESY: HOK AND ALAN KATCHMER

Atelier Dreiseitl (Germany, China, US) Mathew & Gosh Architects (India), Perkins+Will (Canada and US), Lake Flato, SmithGroup, Quinn Evan,s LP3 Architects, AECOM, Integrated Architects, HOK, MSM Architects, M2 Architects, KMD Architects +PLA, GPD Group, VMDO, Waller Todd and Sandler, William McDonough and Associates. USGBC LEED, BREEAM, Living Building Challenge, Green Globes, Passive House Standards. ***Schools, universities, municipal buildings, animal shelters, low income housing, fire stations, grocery stores, industrial buildings, animal feedlots, offices,***

Design For End Use and Reliable Maintenance

www.wiley.com/go/rainwaterharvesting

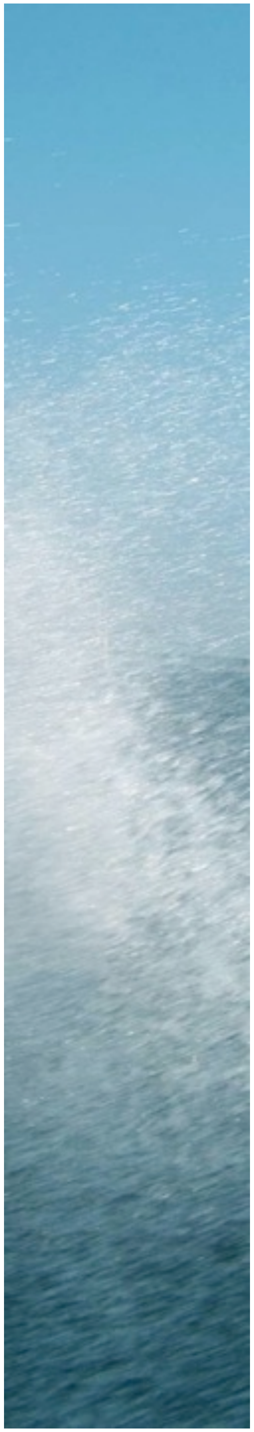


Table 8-1. Water Quality Considerations for Onsite Alternative Water Sources*

Possible Sources	Level of Water Quality Concern					
	Sediment	Total Dissolved Solids (TDS)	Hardness	Organic Biological Oxygen Demand (BOD)	Pathogens (A)	Other Considerations
Rainwater	Low/ Medium	Low	Low	Low	Low	None
Stormwater	High	Depends	Low	Medium	Medium	Pesticides and fertilizers
Air Handling Condensate	Low	Low	Low	Low	Medium	May contain copper when coil cleaned
Cooling Tower Blowdown	Medium	High	High	Medium	Medium	Cooling tower treatment chemicals
Reverse Osmosis and Nanofiltration Reject Water	Low	High	High	Low	Low	High salt content
Gray Water	High	Medium	Medium	High	High	Detergents and bleach
Foundation Drain Water	Low	Depends	Depends	Medium	Medium	Similar to stormwater

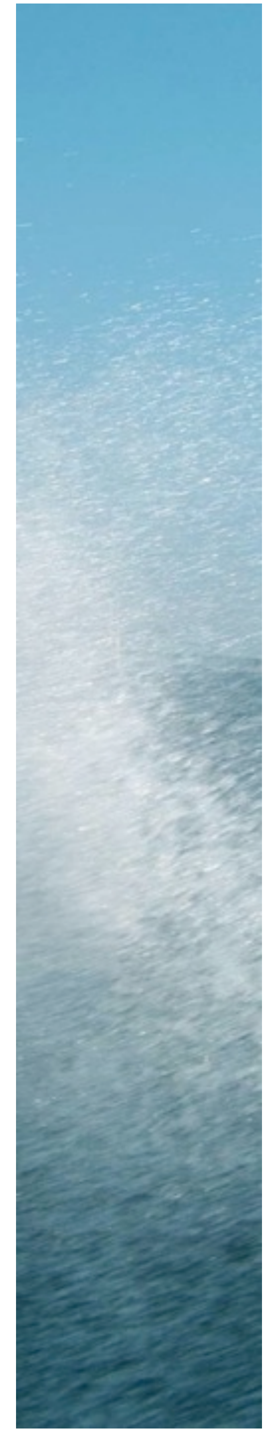
Note: The use of single-pass cooling water is also a possible source of clean onsite water, but facility managers should first consider eliminating single-pass cooling because of its major water-wasting potential. For that reason, it is not included in the list.

*Key:
Low: Low level of concern
Medium: Medium level of concern; may need additional treatment depending on end use
High: High concentrations possible and additional treatment likely
Depends: Dependent upon local conditions
(A): Disinfection for pathogens is recommended for all water used indoors for toilet flushing or other uses

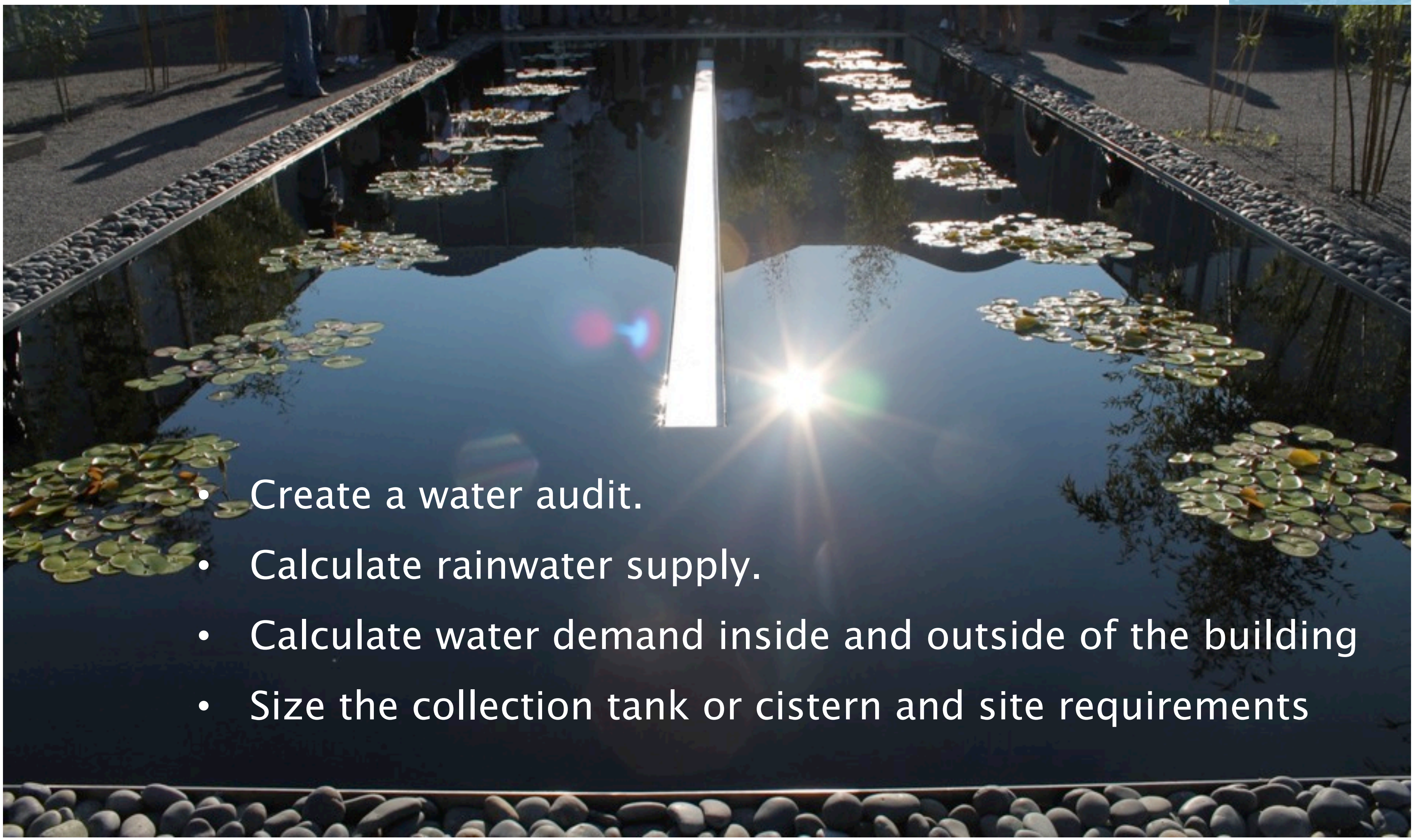
Onsite Alternative Water Sources

Source for Table 8-1: http://www.epa.gov/watersense/commercial/docs/watersense_at_work/#/261/zoomed

For information on Condensate Collection:
http://www.saws.org/conservation/commercial/Condensate/docs/SACCUManual_20131021.pdf

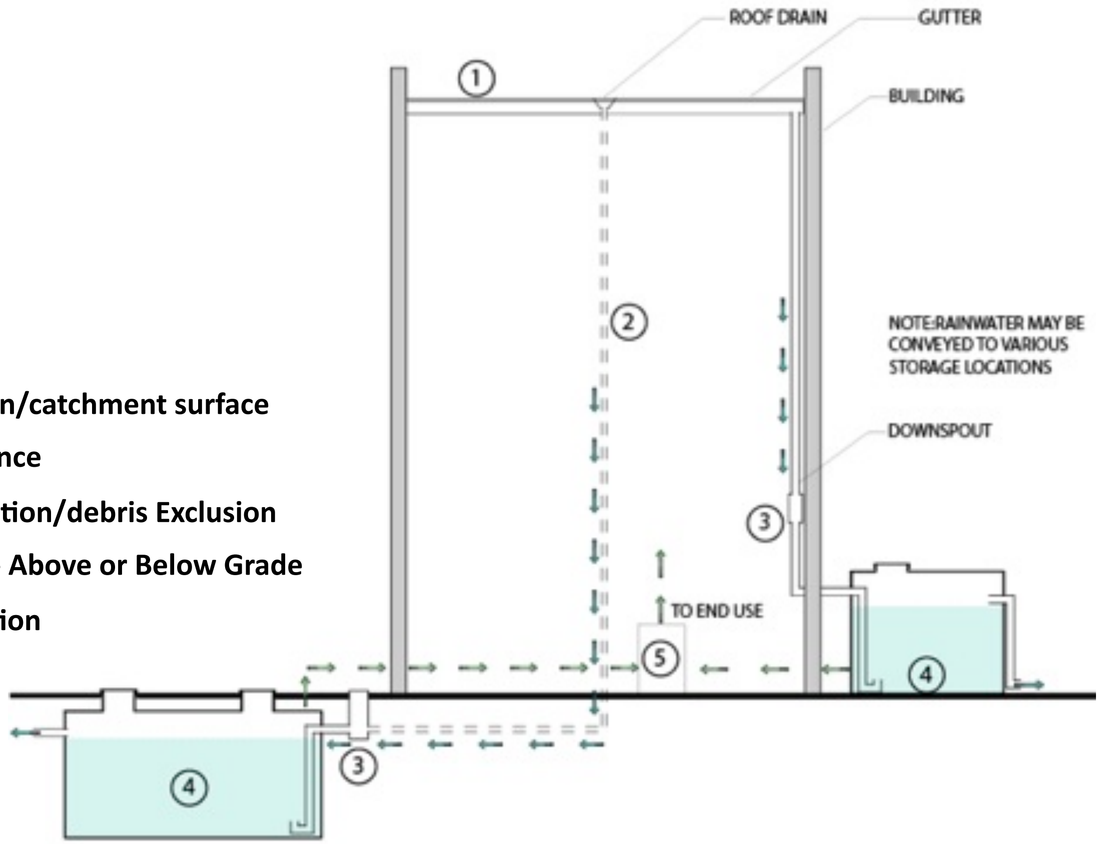


Water Balance Equation (demand = supply)

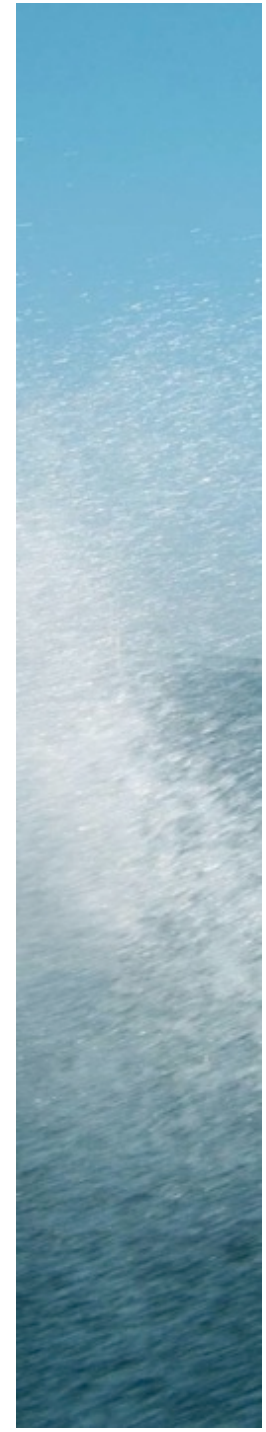


- Create a water audit.
- Calculate rainwater supply.
- Calculate water demand inside and outside of the building
- Size the collection tank or cistern and site requirements

1. Collection/catchment surface
2. Conveyance
3. Pre-filtration/debris Exclusion
4. Storage - Above or Below Grade
5. Distribution



Key Elements of A Rainwater Collection System



$$V_{SUPPLY} = A \times P \times C \times 0.623$$

where V_{SUPPLY} = volume of available water (gal)

P = annual precipitation (in)

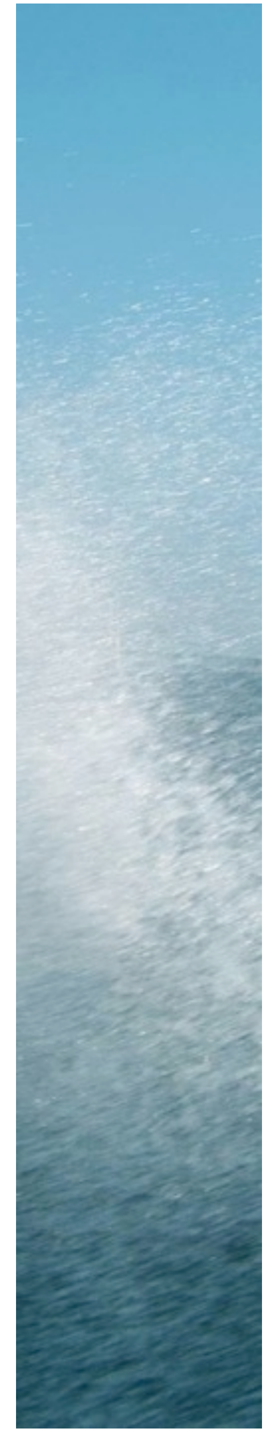
A = collection surface area (ft^2)

C = runoff coefficient (dimensionless)

Note: The value “0.623” is a conversion factor

Collection Formula

NOAA 30 year data on annual rainfall and precipitation easy to find.



$$Cost_{RWH} - Cost_{MW} = ROI$$

Where $Cost_{RWH}$ = cost of rainwater harvesting system ($),

$Cost_{MW}$ = cost of municipal water over time ($)

OR

$$Cost_{RWH} - Cost_{MW} - ED - PP - RR - SI - HT - MF - BA - MB = ROI$$

ED = environmental degradation ($)

PP = pollution prevention ($)

RR = river restoration ($)

SI = stormwater infrastructure ($)

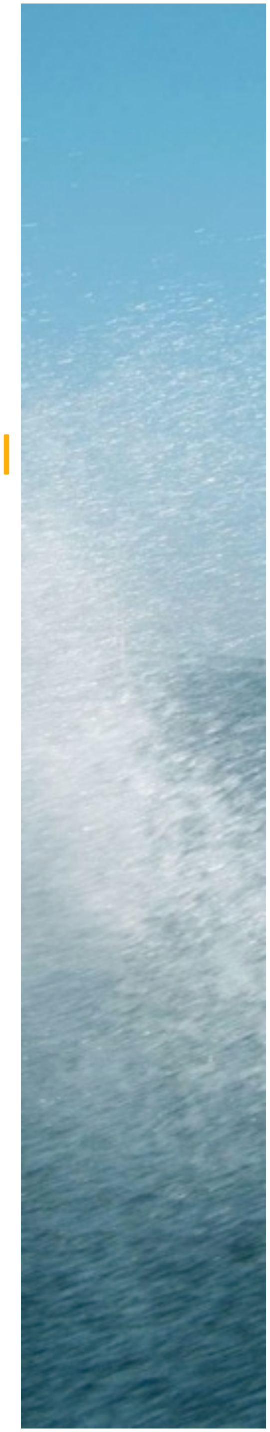
HT = increase in tax rates ($)

MF = municipal fees ($)

BA = increase in buildable area ($)

MB = costs associated with market branding ($)

A New Return On Investment



A modern decentralized water infrastructure can include site-collected rainwater, graywater, stormwater, and blackwater systems.

•*These alternative water sources may* ***never*** *totally replace centralized systems*.

•They do help manage and store water and treat it to various levels of quality for use in buildings/ sites.

•By designing the site and building as a complete system for water storage and use, designers can ***conserve water resources, save energy, and reduce the cost to community treatment facilities.***

Decentralized Water Infrastructures

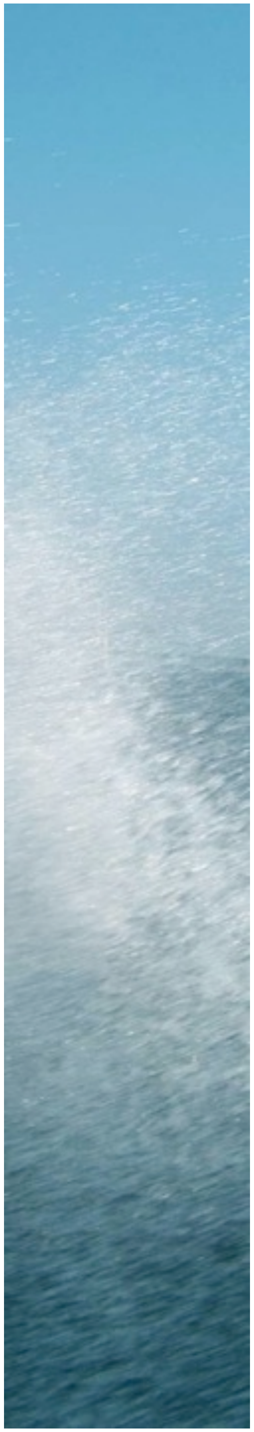
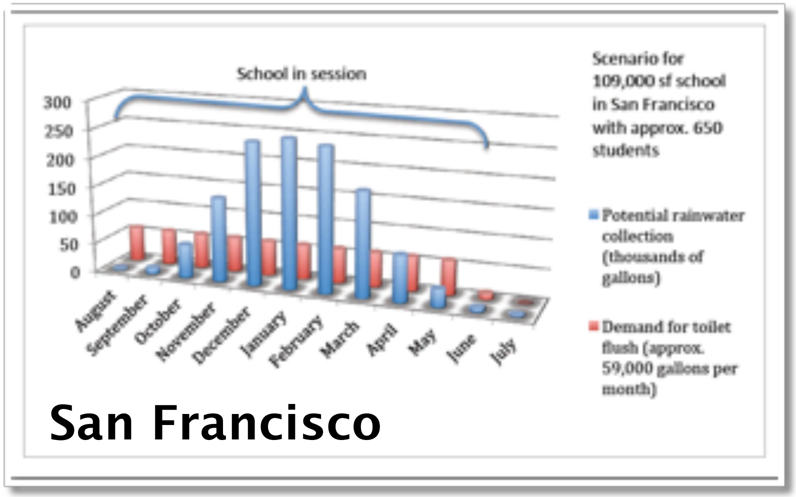


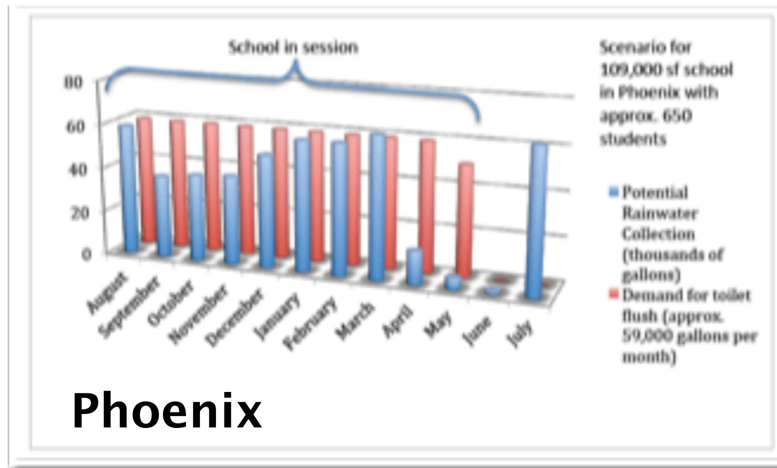
Table E-26
Modeled Water Use per Student

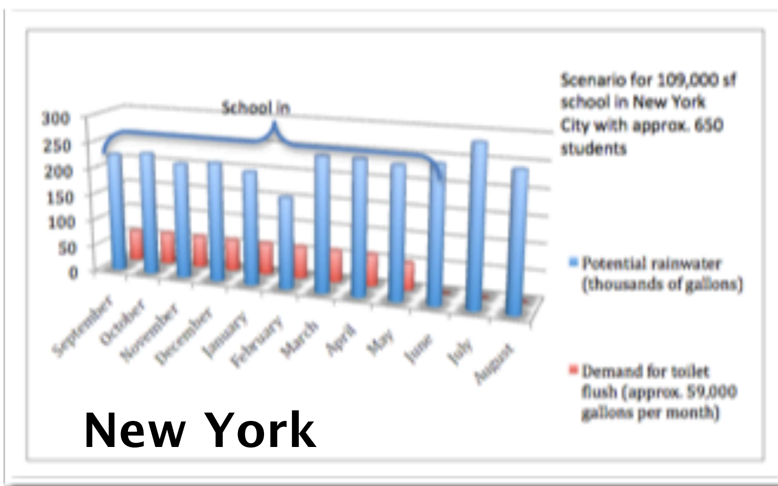
End Uses	Unit Measuring Area or Volume of Use	Area or Volume	Unit Measuring Frequency of Use	Frequency of Use	Total gal/ student/ day
Elementary and Middle Schools					
Irrigation[1]	irrigated acres/student	0.004	gal/acre/school day	varies	24.3
Toilet[2]	gpf	3.00	visits/day	2.11	6.3
Urinal[3]	gpf	1.60	visits/day	1.01	1.6
Faucet Use[4]	gpf	0.11	flushes/day	3.12	0.3
Kitchen	gal/meal	9.91[5]	meals/day/student	0.4[6]	4.0
Other[7]					2.0
Total					**38.5**
High Schools					
Irrigation[1]	irrigated acres/student	0.008	gal/acre/school day	varies	55.6
Toilet[2]	gpf	3.00	visits/day	2.11	6.3
Urinal[3]	gpf	1.60	visits/day	1.01	1.6
Faucet Use[4]	gpf	0.11	flushes/day	3.12	0.3
Kitchen	gal/meal	9.91[5]	meals/day/student	0.4[6]	4.0
Other[7]					4.0
Total					**71.8**
Other Schools					
Irrigation	irrigated acres/student	0.002	gal/acre/school day	varies	6.9
Toilet[8]	gpf	3.00	visits/day	1.03	3.1
Urinal[9]	gpf	1.60	visits/day	0.39	0.6
Faucet Use	gpf	0.11	min/day	0.96	0.1
Kitchen	gal/meal	9.91	meals/day/student	0.4	4.0
Other					1.0
Total					**15.7**

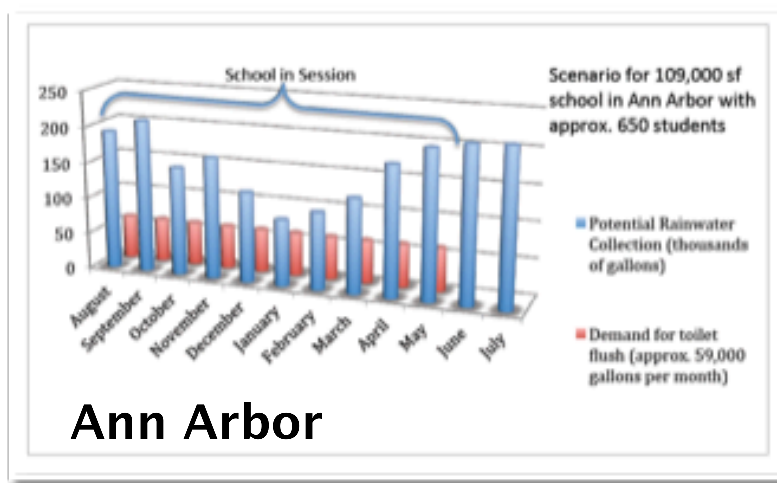
Water Use In Schools

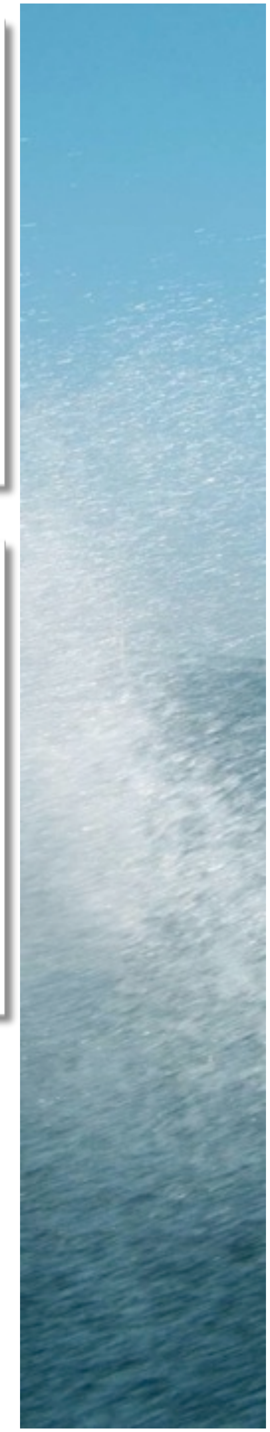
PAC InstituteSource for many demand tables http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/appendix_e3.pdf









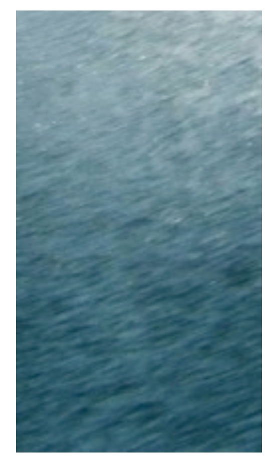


Rainwater For Similar Schools In Different Climate Zones

City	Average Annual Rainfall (inches)	Potential Annual Collection of Rainwater from Roof (gallons)	Annual Water Demand for Toilet Flushing (gallons) in Typical Middle School (average of 10-month school year)	Potential Annual Surplus (gallons)
Atlanta	49.71	3,038,091.27	590,000	2,448,091.27
Ann Arbor	32.81	2,005,225.803	590,000	1,415,225.80
New York	47	2,872,466.10	590,000	2,282,466.1
Phoenix	8.22	502,375.99	590,000	-87,624.01
San Francisco	20.69	1,264,496.25	590,000	674,496.25

Example: Comparison of Rainwater Collection in Five Schools

Less than a 100,000 gallon deficit. Potentially could be made up with condensate or another source such as gray water use.



Fowler Drive Elementary – Atlanta, Georgia

Even with a smaller roof than hypothetical examples, two 10,000 gallon tanks support the needs of the school with a four year payback!

Table 1: Suggested Maintenance Procedures for Rainwater Harvesting Systems

Activity	Frequency
Keep gutters and downspouts free of leaves and other debris	O: Twice a year
Inspect and clean pre-screening, inlet filtration devices, and first flush diverters	O: Four times a year
Inspect and clean storage tank lids, paying special attention to vents and screens on inflow and outflow spigots. Check mosquito screens and patch holes or gaps immediately	O: Once a year
Inspect condition of overflow pipes, overflow filter path, and/or secondary runoff reduction practices	O: Once a year
Inspect tank for sediment buildup	I: Every third year
Clear overhanging vegetation and trees over roof surface	I: Every third year
Check integrity of backflow preventer (unless required more frequently by state or local regulations)	I: Every third year
Inspect structural integrity of tank, pump, pipe, and electrical system	I: Every third year
Replace damaged or defective system components	I: Every third year
Key: O = Owner; I = qualified third party Inspector	

Source: Virginia DCR Stormwater Design Specification No. 6 – Rainwater Harvesting

Maintenance

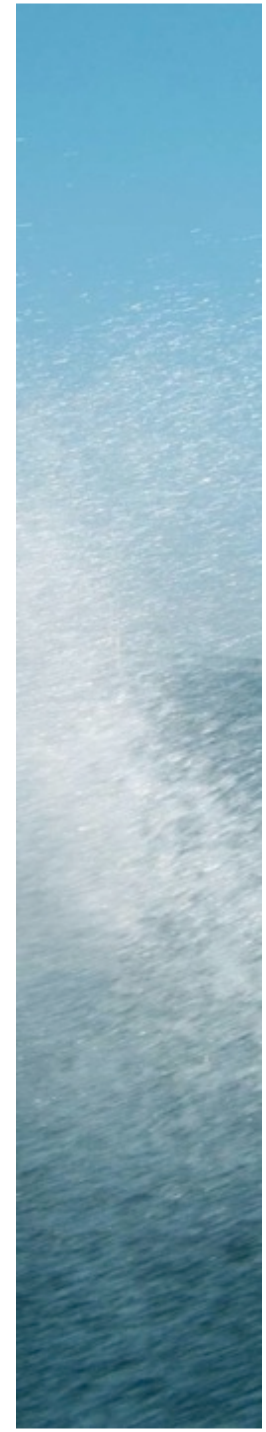
http://water.epa.gov/polwaste/nps/upload/rainharvesting.pdf

“When you are looking at setting standards for water quality you need to think about two things.

Obviously the major thing is to protect the health and safety of the end user. … and …. You need to take into account the reactivity and the quality of the water so as to protect the end use device. . . .***It is incumbent on us to get it right.”***

Shawn Martin,
Director of Plumbing, Mechanical and Gas (PMG) activities in the Government Relations Group, Plumbing and Mechanical Code Developer for the International Code Council (ICC)

Pollution Impact



Rooftop runoff, often referred to as 'clean runoff' may contain pollutants, but "generally in lower concentrations and absent many of the toxics present in runoff from other impervious surfaces." – U.S. EPA Municipal Handbook on Rainwater Harvesting Policies

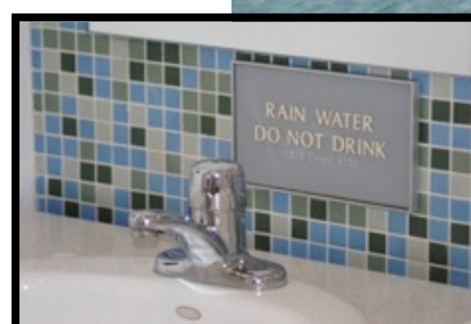
Pollutants

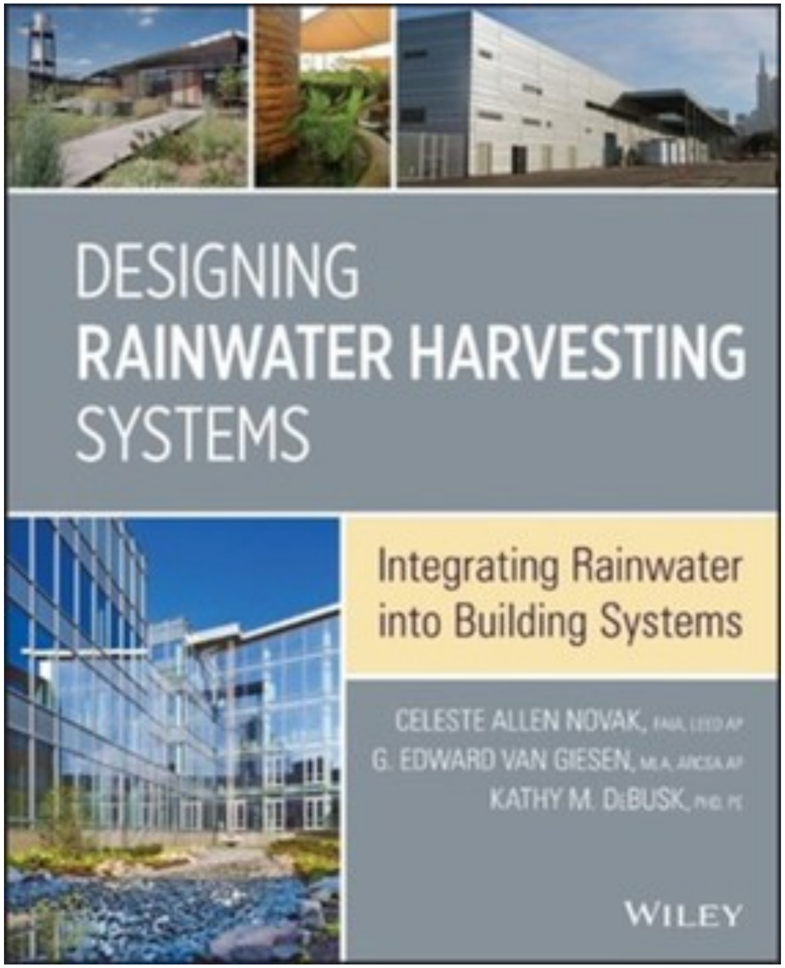
1. Adopt stormwater pollution control standards that require on-site volume retention and allow rainwater harvesting and reuse, with appropriate health and safety standards, to be used to meet that requirement, thereby creating an incentive for on-site capture.
2. Adopt standards that require or promote rainwater harvesting and/or water efficiency
3. Review building, health, and plumbing codes for barriers to capturing or reusing rainwater
4. Provide incentives for decreasing stormwater runoff and promoting water conservation
5. Require use of rainwater harvesting and reuse on all public properties

Acceptance

Capturing Rainwater from Rooftops: An Efficient Water Resource Management Strategy that Increases Supply and Reduces Pollution

www.nrdc.org/water/files/rooftoprainwatercapture.pdf





Resources

Author contacts for more information:

Celestenov@aol.com - General and case studies

Vangiesen12@icloud.com - Installations and policy

Kmdebusk@gmail.com - Stormwater design planning and pollution impact