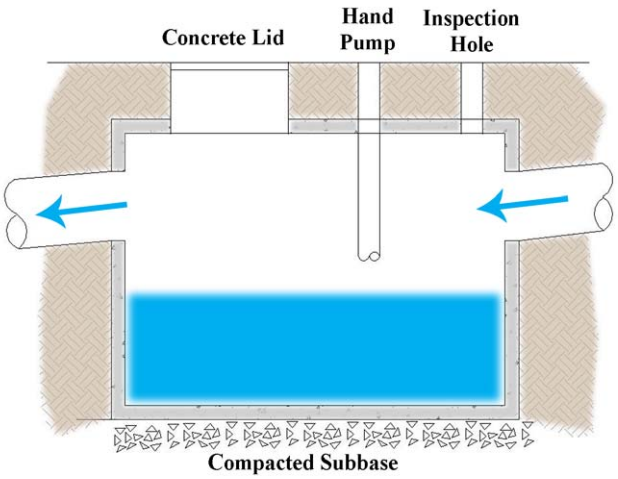
Structural BMP Criteria

BMP #: Capture and Reuse



Capture and Reuse encompasses a wide variety of water storage techniques designed to "capture" precipitation, hold it for a period of time, and reuse the water or slowly release it over time.

Key Design Elements

- Storage devices designed to capture a portion of the small, frequent storm events
- Storage techniques may include cisterns, underground tanks, aboveground vertical storage tanks, "rain barrels", or other systems.
- Systems must provide for overflow or bypass of large storm events
- Collection and placement of storage elements up gradient of areas of reuse may reduce or eliminate pumping needs
- Water must be used or discharged before next storm event.
- Most effective when designed to meet a specific water need for reuse.

Potential Applications

Residential Subdivision:	**Yes**
Commercial:	**YES**
Ultra Urban:	**YES**
Industrial:	**YES**
Retrofit:	**YES**
Highway/Road:	**LIMITED**

Stormwater Functions

Volume Reduction:	**Med./High**
Recharge:	**Low**
Peak Rate Control:	**Low***
Water Quality:	**Medium**

** Depending on design scale*

Pollutant Removal

Total Suspended Solids:	**x**
Nutrients:	**x**
Metals:	**x**
Pathogens:	**x**

Other Considerations:

- Guidelines for Infiltration Systems apply if designed with Infiltration

Description

Cisterns, Rain Barrels, Vertical Storage, and similar devices have been used for centuries to capture storm water from the roofs of buildings, and in many parts of the world serve these systems serve as a primary water supply source. In the U.S., the reuse of stormwater for potable needs is not advised without water treatment, although many homes in the U.S. were storing water in cisterns for reuse as little as one-hundred years ago. In the U.S. these systems can reduce potable water needs for issues such as irrigation and fire storage while also reducing stormwater discharges.

Storage/reuse techniques range from small, residential systems such as Rain Barrels that are maintained by the homeowner to supplement garden needs, to large, "vertical storage" units that can provide fire needs. Storage/reuse techniques are useful in urban areas where there is little physical space to manage storm water.

Variations

Cisterns – large, underground or surface containers designed to hold large volumes of water (500 gallons or more). Cisterns may be comprised of fiberglass, concrete, plastic, brick or other materials.

Figure 1. Cisterns are available from a variety of manufacturers, in a variety of sizes and materials.

Rain barrels – barrel (or large container) that collect drainage from roof leaders and store water until needed for irrigation.

Figure 2. Rain Barrels are available in a variety of materials and sizes

Vertical Storage – stand along “towers”, or “fat downspouts” that usually rest against a building performing the same capture, storage and release functions as cisterns and rain barrels.

Figure 3. Vertical storage units for vegetated roof plaza maintenance are common in Germany

Storage Beneath Structure – Storage may be incorporated into elements such as paths and walkways to supplement irrigation with the use of structural plastic storage units, such as RainStore or other products.

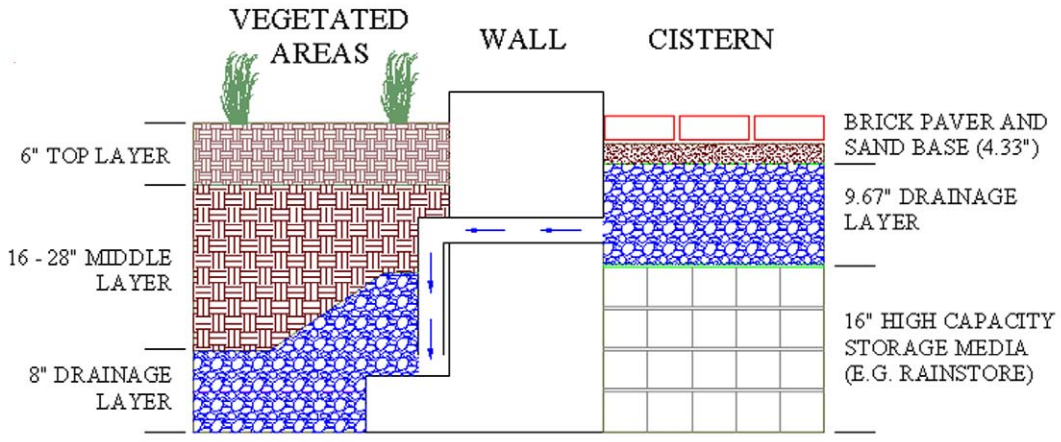


Figure 4. Cross-section detail showing storage of roof runoff beneath brick walkway using RainStore units.

Figure 5. RainStore

Applications

- Landscaped areas and gardens to meet irrigation needs
- Storage for fire needs
- Urban areas and Combined Sewer areas to reduce peak surcharges.
- Reuse for greywater needs such as flushing toilets.
- Reuse for athletic field irrigation

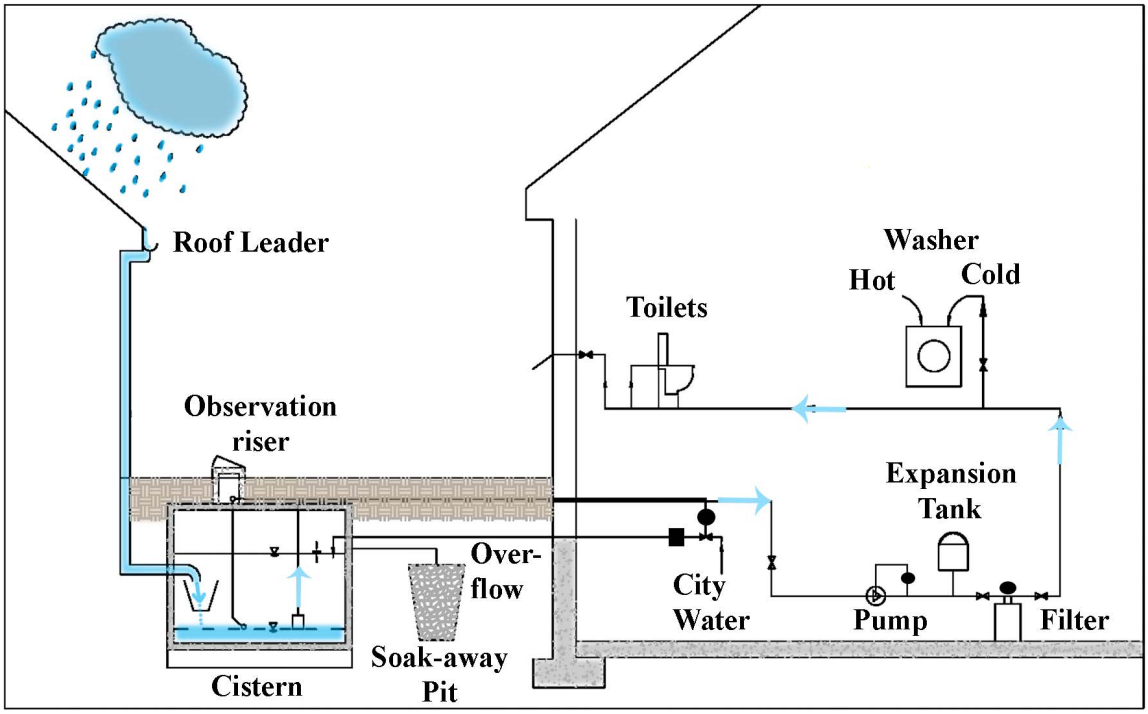


Figure 6. Cistern harvesting system for reuse to meet greywater needs (modified, from www.advancedbuildings.org/_frames/fr_t_plumbing_cisterns.htm)

Figure 7. Excavation of former residential water supply cistern in Ann Arbor, Michigan.

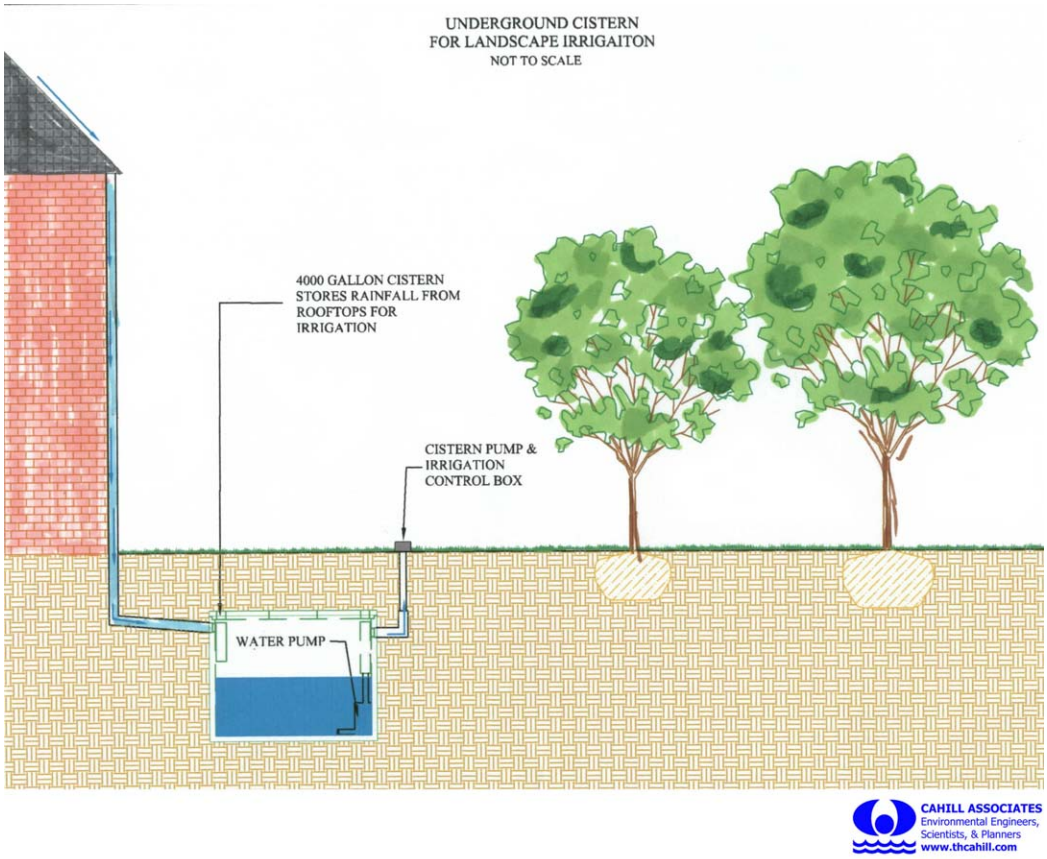


Figure 8. Schematic cross-section showing roof runoff connected to underground cistern.

Design Considerations

1. The Designer must **calculate the water need** for the intended uses. For example, what will the collected water be used for and when will it be needed? If a 2,000 square foot area of lawn requires irrigation for 4 months in the summer at a rate of 1" per week, how much will be needed and how often will the storage unit be refilled? The usage requirements and the expected rainfall volume and frequency must be determined.

2. **Drawdown** – the Designer must provide for use or release of the stored water between storm events in order for the necessary stormwater storage volume to be available.

3. The **Catchment Area** on which the rain falls must be considered. The catchment area typically handles roof runoff.

4. The **Conveyance System** must keep reused stormwater or greywater from other potable water piping systems. Do not connect to domestic or commercial potable water system.

5. Pipes or storage units should be clearly marked "Caution: Reclaimed water, Do Not Drink".

6. Screens may be used to filter debris from storage units.

7. The **first flush** runoff may be diverted away from storage in order to minimize sediment and pollutant entry.

8. Storage elements should be protected from direct sunlight by positioning and landscaping. (Limit light into devices to minimize algae growth.)

9. The proximity to building foundations should be considered for overflow conditions.

10. Climate is an important consideration, and capture/reuse systems should be disconnected during winter to prevent freezing.

11. Cisterns should be watertight (joints sealed with nontoxic waterproof material) with a smooth interior surface, and capable of receiving water from rainwater harvesting system.

12. Covers (lids) should have a tight fit to keep out surface water, animals, dust and light.

13. Positive outlet for overflow should be provided a few inches from the top of the cistern.

14. Observation risers should be at least 6" above grade for buried cisterns.

15. Reuse may require pressurization. Water stored has a pressure of 0.43 psi per foot of water elevation. A ten-foot tank would have a head of 0.43*10 = 4.3 psi. Most irrigation systems require at least 15 psi. To add pressure, a pump, pressure tank and fine mesh filter can be used, which adds to the cost of the system, but creates a more useable system.

Table 1. Annual Rainfall Yield (Gallons) for Impervious Surfaces (Square feet)

Annual Rainfall Yield in Gallons for Various Impervious Surface Sizes and Rainfall									
Impervious Surface	Rainfall								
	20	24	28	32	36	40	44	48	52
sf	inches								
1000	11844	14213	16582	18951	21319	23688	26057	28426	30795
1100	13029	15634	18240	20846	23451	26057	28663	31268	33874
1200	14213	17056	19898	22741	25583	28426	31268	34111	36954
1300	15397	18477	21556	24636	27715	30795	33874	36954	40033
1400	16582	19898	23214	26531	29847	33164	36480	39796	43113
1500	17766	21319	24873	28426	31979	35532	39086	42639	46192
1600	18951	22741	26531	30321	34111	37901	41691	45481	49272
1700	20135	24162	28189	32216	36243	40270	44297	48324	52351
1800	21319	25583	29847	34111	38375	42639	46903	51167	55431
1900	22504	27005	31505	36006	40507	45008	49508	54009	58510
2000	23688	28426	33164	37901	42639	47377	52114	56852	61589
2100	24873	29847	34822	39796	44771	49745	54720	59694	64669
2200	26057	31268	36480	41691	46903	52114	57326	62537	67748
2300	27241	32690	38138	43586	49035	54483	59931	65380	70828
2400	28426	34111	39796	45481	51167	56852	62537	68222	73907
2500	29610	35532	41454	47377	53299	59221	65143	71065	76987
2600	30795	36954	43113	49272	55431	61589	67748	73907	80066
2700	31979	38375	44771	51167	57562	63958	70354	76750	83146

Table 2. Capacities (cubic feet) of Cisterns, by depth and diameter

Capacities of Various sized Cisterns (cf)							
	Diameter of Round Types (ft)						
Depth (ft)	**6**	**8**	**10**	**12**	**14**	**16**	**18**
6	1266	2256	3522	5076	6906	9018	11412
8	1688	3008	4696	6768	9208	12024	15216
10	2110	3760	5870	8460	11510	15030	19020
12	2532	4512	7044	8532	13812	18036	22824
14	2954	5264	8218	11844	16114	21042	26628
* Harvested Rainwater Guidelines, GreenBuilder.com							

Detailed Stormwater Functions

Volume Reduction Calculations:
Volume reduction is actual volume of container, taking into consideration how many times it is emptied.

Peak Rate Mitigation Calculations: Overall, capture and reuse takes a volume of water out of site runoff and puts it back into the ground. This reduction in volume will translate to a lower overall peak rate for the site.

Water Quality Improvement: Pollutant removal takes place through sedimentation of primary storage, and/or natural filtration through soil and vegetation. Quantifying pollutant removal will depend on design. Sedimentation will depend on area below outlet that is designed for sediment accumulation, time in storage, and maintenance frequency. Filtration through soil will depend on flow draining to an area of soil, the type of soil (infiltration capacity), and design specifics (stone bed, etc.).

Construction Sequence

Install per manufacturer's instructions.

Maintenance Issues

Flush cisterns to remove sediment. Brush the inside surfaces and thoroughly disinfect.

Winter concern: Do not allow water to freeze in devices. (Empty out before water freezes.)

Cost Issues

Rain Barrel: ranges from $80 to $200, average for residential use is $150

Cistern: varies, depending on material used (reinforced concrete, steel, plastic are common), size, and pump characteristics

Vertical Storage: ranges from $88 for 64-gallon capacity to $10,516 for 12,000-gallon capacity (for a plastic, manufactured product)

General: the reuse of water for irrigation or other uses saves money on water costs over time.

Specifications:

Vertical Storage:

1. Polyethylene black plastic (meet FDA specs for stored drinking water if that is the purpose)

Additional Sources / References

City of Tucson, Water Harvesting Guidance Manual, March 2003 (edited by Ann Audrey Phillips, prepared for the City of Tucson, Department of Transportation, Stormwater Section)

"What are Rainwater Harvesting and Stormwater Recycling?" Heather Kinkade-Levario, ASLA and Hari Krishna Ph.D., P.E., Ann Phillips, Tim Pope

Sustainable Building Sourcebook, "Harvested Rainwater Guidelines", sections 1.0, 2.0, 3.0 www.greenbuilder.com

"Rainwater Harvesting" www.ci.austin.tx.us/greenbuilder/fs_rainharvest.htm City of Austin, TX

Portland, OR's Code Guide Office of Planning & Development Review "Rainwater Harvesting – ICC – RES/34/#1 & UPC/6/#2, March 2001

U.S. EPA National Pollutant Discharge Elimination System, "Post-Construction Storm Water Management in New Development & Redevelopment, On-Lot Treatment"

City of Vancouver, Engineering Services, Water and Sewers "Rain Barrel Program"

"Cisterns/Rainwater Harvesting Systems, www.advancedbuildings.org Technologies and Practices, Plumbing & Water Heating

CSIRO, Land and Water, "Urban Water Reuse – Frequently Asked Questions" (south Australia)

"Rain Barrels – Truth or Consequences" Karen Sands, AICP and Thomas Chapman, P>E., Milwaukee Metropolitan Sewerage District, Milwaukee, Wisconsin

"Hydrologic Processes at the Residential Scale" Qingfu Xiao, E. Gregory McPherson, James R. Simpson, Hydrologic Sciences Program, UC Davis, Center for Urban Forest Research, USDA Forest Service

"Black Vertical Storage Tanks by Norwesco" www.precisionpump.net/storagetanksystems.htm