

Rainwater and Snowmelt Harvesting in Colorado

Archeological evidence points to rainwater harvesting in China and the Middle East dating back 4,000 to 6,000 years ago. Closer to home, Native Americans in the four-corners area used this resource along with systems of canals to redirect and reuse the water to meet their needs. Rainwater harvesting was historically implemented in arid and semi-arid regions, as a source of domestic water and for irrigation and livestock use.

Rainwater harvesting remains popular today across the world and throughout the western United States, including areas that are more arid than Colorado. It is not being practiced in Colorado primarily

because Colorado water law severely inhibits its use. The purpose of this document is to provide information on rainwater harvesting and to describe how proposed legislation could allow Coloradans to test the concept at a local level while protecting existing water users.



Woman Drawing Water from Cistern at Orabi Pueblo (circa 1880-1900)

source: www.ancestral.com/cultures/north_america/hopi.html

How Does It Work?

Simply stated, rainwater harvesting is the capture and storage of rainwater and snowmelt at the location where it occurs. In Colorado, most of this water resource comes in the spring while the highest demand for water, which is associated with outdoor water use, is in the summer. By capturing and storing runoff from rooftops (and even sidewalks and other impervious areas), the precipitation can be better managed and used at times of greatest need.

The simplest rainwater harvesting system doesn't have to include storage – just a rooftop and gutter system. Many homeowners actually practice this by extending downspouts from gutters and directing rain and snowmelt across lawns and gardens.



source: www.basementsystemscolorado.com

To gain the most benefit, one or more storage tanks or “cisterns” are added. A simple domestic rainwater harvesting system is provided in Figure 2-1 of the Texas Manual on Rainwater Harvesting. The major components include:

- Catchment surface – generally a roof, a gutter, and downspout system
- First flush diverter – used to remove leaves and other debris as well as sediment that has built up on the roof surface
- Cistern/storage – this can include tanks, pipes, and enclosed portions of buildings, above or below ground
- Delivery system – this can be accomplished with a gravity system or include pumps and pipes to move water from the cistern into an irrigation system
- Final water quality treatment – screen systems/basic mechanical filtration is typically adequate for irrigation and toilet flushing; higher level treatment can be included for potable uses.

Above-ground storage options include anything from a small rain barrel to a traditional storage tank. Larger storage facilities are often constructed underground.

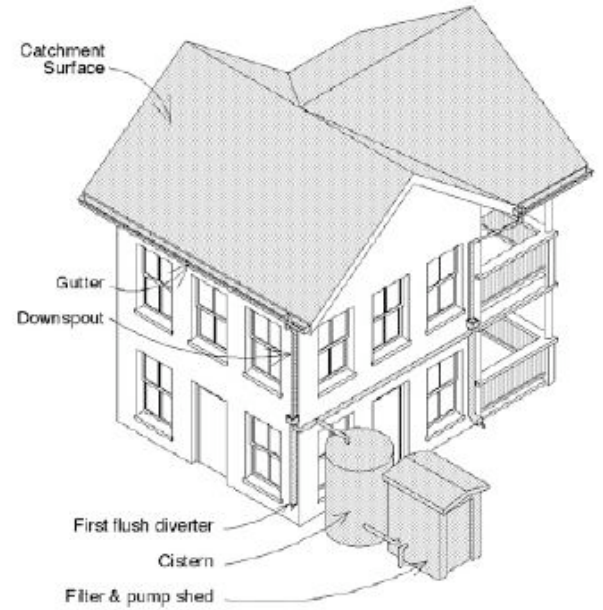


Figure 2-1. Typical rainwater harvesting installation



Small Scale Rain Barrel
source: RainBarrelSource.com



Construction of an Underground Structural Storage Tank in Rancho Viejo, New Mexico



Underground Residential Cistern
source: Terry McMains

Communal systems capture flow from multiple locations, such as in an apartment complex or commercial development, and deliver water to common irrigated areas. With costs shared between multiple users, the individual costs can be less than half of what it would be with individual systems.

In addition to structural systems, rainwater harvesting can be practiced on a larger scale, within a subdivision, for example, where rain or snowmelt is collected from impervious surfaces and stored in regional catchments for later irrigation use. These systems integrate rainwater harvesting into the stormwater control systems that are mandatory for most developments.



Regional Rainwater Catchments
Daybreak Community – Salt Lake City, Utah
source: Design Workshop

A vast amount of literature, case studies, and other resources exist related to rainwater harvesting systems, including companies that specialize in the design and installation. The amount of information has increased significantly over the past decade, as sources of water become harder to come by and general awareness and support for conservation of natural resources has grown.

What are the Benefits?

Benefits of rainwater harvesting include:

- It provides a source of water supply located close to where the water is needed (example: runoff from rooftops used to irrigate adjacent lawns and gardens)
- Could help reduce the amount of water transferred out of agriculture and/or across basins for domestic and municipal irrigation as Colorado continues to grow
- Irrigated landscape benefits – plants thrive more with rainwater than treated water
- Reduces flow to stormwater drains, and thus reduces erosion and downstream flooding
- Reduces stormwater pollution and helps keep fertilizers, pesticides, etc. from being transported to rivers and ground water, improving water quality in urban stream systems
- Helps utilities reduce the amount of treated water during the summer peak and delays need for water treatment plant expansions
- Incorporated in “green building”, rainwater harvesting systems can provide U.S. Green Building Council LEED points in the categories of stormwater design quantity control, water efficiency, and design innovation
- Reduces consumer water bills and energy used to treat and deliver water for outdoor uses.

As part of a four-step process for planning new development and significant re-development, the Colorado Urban Drainage and Flood Control District (UDFCD) recommends minimizing directly connected impervious

areas – reducing paved areas and other impervious surfaces and routing stormwater runoff over vegetated areas to slow it down and promote infiltration. The stated benefits are related to reducing stormwater pollution and less cost for drainage infrastructure. Rainwater harvesting is a mechanism that can be used to accomplish these same goals.

Then Why Not?

Colorado’s water rights system is based on the prior appropriation doctrine, “first in time, first in right”, which protects senior water rights. All precipitation is assumed to ultimately contribute to stream flows and is part and parcel of the water that existing water rights are entitled to. Current Colorado water law requires 100% of precipitation that is captured to be replaced in like time, place, and amount. This does not account for the fact that some of the precipitation may have historically been consumed by native vegetation and never made it back to the stream. There are non-irrigated areas throughout the state, such as the one shown here in northwest Douglas County, where green fields in the spring and early summer provide evidence that some of the precipitation was consumed by the vegetation.



Non-Irrigated Native Vegetation in Northwest Douglas County

Colorado has two statutory exceptions that actually recognize that not all precipitation contributes to stream flows. These two exceptions allow credit for the amount of precipitation that was historically consumed by native vegetation to offset evaporation replacement requirements: C.R.S. §37-84-117(5) concerning on-stream reservoirs and C.R.S. §37-80-120(5) and C.R.S. §37-92-305(12)(a) concerning gravel pits. The Division of Water Resources has Guidelines for calculating the amount of “credit” from the historical consumption by native vegetation, and generally allows credit for up 70% of the total precipitation for each month. Through a series of court cases, several groups attempted to obtain water rights by eliminating vegetation that historically consumed water, often referred to as “salvage water”. The Colorado Supreme Court rejected each case, however noting, “No one on any river would be adverse to a schematic and integrated system of developing this kind of water supply with control and balancing considerations. But to create such a scheme is the work of the legislature ...” *Southeastern Colorado Water Conservancy Dist. v. Shelton Farms, Inc.*

Douglas County Case Study

The Colorado Water Conservation Board recently funded a study under its Water Efficiency Grant Program which included an investigation of the potential benefits of rainwater harvesting when paired with water-efficient landscaping and irrigation practices in northwest Douglas County. Entitled “Holistic Approach to Sustainable Water Management in Northwest Douglas County”, the study was co-sponsored by the County and a group of Douglas County water providers and water users. The study looked at the fate of precipitation at an undeveloped (native vegetation) site in northwest Douglas County and found that in a dry year, none of the precipitation returned to the stream or ground water. In a wet year, up to 15% of the precipitation returned and on average, only 3% of the precipitation returned. **On average, 97% of the precipitation was consumed by the native vegetation and never returned to the stream system.**



Example of Water Wise Landscaping

The study considered the benefits of pairing rainwater harvesting in northwest Douglas County with water wise landscaping, which included 1,000 square feet of turf and 500 square feet of plantings. With a 1,500 square foot roof and 5,000 gallon cistern, even after considering some losses in the capture process, the study found that, on average, rainwater could provide almost half of the supply for water wise landscape. Typical residential underground cisterns run around \$10,000 to \$15,000 (installed) whereas the above ground systems are significantly less expensive. Although there is initial investment for the underground system, the homeowner and the water provider realize multiple savings from the benefits described above. The payback period was

not analyzed in this study, but it recognized that benefits are amplified in water-supply challenged areas.

After an in-depth review of the history of Colorado statutes and case-law, the study concluded that rainwater harvesting could be implemented in new developments while protecting existing water rights through utilizing the legal framework of an augmentation plan. The water court process used to obtain the augmentation (i.e. replacement) plan would allow existing water rights holders an opportunity to evaluate the plan and provide terms and conditions to protect the historical yield of their water right. The study recommended policy makers consider authorizing a pilot project to verify the study results and evaluate how cisterns and other rainwater collection systems are constructed and operated. This would provide an opportunity to further identify the “control and balancing considerations” recommended by the Colorado Supreme Court in the Shelton Farms case. Additional information can be found at: www.cwcb.state.co.us/Conservation/RelatedInformation/Publications/ (“Holistic Approach to Sustainable Water Management in Northwest Douglas County”, 2007, Leonard Rice Engineer, Inc., Meurer and Associates, and Ryley, Carlock, and Applewhite)

Rainwater Harvesting in Other Western States

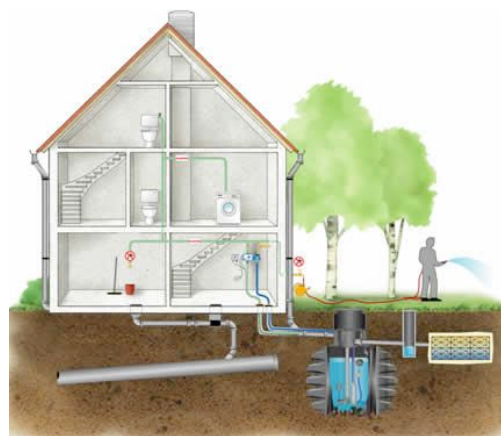
Rainwater harvesting is practiced in most western states and significant research has been conducted in this field in the states of Arizona, California, Texas, New Mexico, Oregon, Utah, and Washington. Reportedly, only the states of Washington, Oregon, Montana, and Colorado have explicit jurisdiction over atmospheric water. Colorado is the only state that enforces its jurisdiction while Oregon is at the other extreme and passed a senate bill in 1995, exempting all rainwater collection from impervious surfaces. Some examples of specific efforts in other states are provided below.

New Mexico: New Mexico has a Rainwater/Snowmelt Harvesting Policy which states “The New Mexico Office of the State Engineer supports the wise and efficient use of the state’s water resources; and, therefore, encourages the harvesting, collection and use of rainwater from residential and commercial roof surfaces for on-site landscape irrigation and other on-site domestic uses. The collection of water harvested in this manner should not reduce the amount of runoff that would have occurred from the site in its natural, pre-developed state. Harvested rainwater may not be appropriated for any other purposes.” In 2003, the Santa Fe County Board of County Commissioners adopted an ordinance requiring all commercial developments to collect all roof drainage

into cisterns for use in landscape irrigation. All residential development is required to collect roof drainage from a minimum of 85% of roof area for landscape irrigation. Homes with at least 2,500 square feet of heated area must install underground, partially buried, or insulated cisterns, while homes under 2,500 square feet of heated area must submit a rainwater catchment plan with their development permit application. The ordinance is somewhat restrictive in that it requires underground cisterns, which are significantly more expensive than above ground units. Recent failed attempts for a similar ordinance in Albuquerque are believed to have failed primarily due to specification for underground units. (Additional information: City of Albuquerque, March 1995. *Rainwater Harvesting Supply from the Sky, A Publication of the City of Albuquerque* and www.ose.state.nm.us/water-info/conservation/rainwater.html)

Oregon: In 2008, Oregon’s Department of Consumer and Business Services’ Building Codes Division approved two new methods that allow homeowners to harvest rainwater and reuse wastewater. The first method involves reusing certain wastewater in homes when the owner installs water conservation systems. The water conservation systems treat water drained from bathtubs, showers, bathroom sinks, washing machines, and laundry tubs, and then store the water for use in flushing toilets. California, Washington, Ohio, Texas, Arizona, New Mexico, and Hawaii, are also working to allow builders and homeowners to install wastewater conservation systems. The second method gives both homes and commercial buildings the ability to collect rainwater from roofs to be used for gardens, flushing toilets, washing clothes, and in heating and air conditioning units. The Building Codes Division took this action as part of the Governor’s agenda for climate change. (Additional information: www.portlandonline.com/OSD/index.cfm?a=114750&c=42113)

Texas: A constitutional amendment passed as Proposition 2 by Texas voters in 1993 exempted pollution control equipment, including rainwater harvesting systems, used for commercial and industrial applications, from property tax. The Texas Legislature also allowed taxing units of government the option to exempt from taxation all or part of the assessed value of a property on which water conservation modifications have been made. The Texas Legislature has passed a number of bills and some local entities such as Hays County have adopted rules providing tax exemptions for rainwater harvesting systems. A few public utilities such as the City of Austin offer rebates and distribute rain barrels at a discounted price to promote rainwater harvesting. Rainwater harvesting systems are also exempt from state sales tax (Senate Bill 2, 77th Texas Legislature, 2001). In addition to tax exemptions, the City of Austin offers rebates and discounts to customers who install rainwater harvesting and condensate recovery systems. The state has published Guidance for Public Water Systems, specifically addressing use of rainwater as a potable water supply, and has recently commissioned a study on the effect of roof material on runoff water quality for rainwater harvesting. (Additional information: Texas Water Development Board, 2005. *The Texas Manual on Rainwater Harvesting, Third Edition, 2005* and www.twdb.state.tx.us/iwt/rainwater/faq.html)



source: www.pimgroup.co.uk/images/rwh.jpg

Washington: The state of Washington allows traditional residential rain barrels without a permit and has allowed rainwater harvesting in select situations where the use was considered “de-minimus”, although that term has not been specifically defined. Every year since 2002, the state has unsuccessfully attempted to pass

legislation to support rainwater harvesting beyond residential rain barrels. While the state has not adopted the concept of requiring an augmentation plan, the most recent attempt requires the state's Department of Ecology to adopt "rules to specify conditions under which rainwater collection facilities may be constructed and operated in order to protect existing water rights and water quality and to prevent the reduction of stream flows to a level detrimental to instream values." The Department of



source: www.ecy.wa.gov/programs/wr/hq/rwh.html

Ecology is currently working to create a rule that will acknowledge and clarify Ecology's historical exceptions for small, de-minimus capture and use of rainwater from the water code. The rule would also create a permit system for entities that plan to construct rainwater collection systems that do not qualify for the permit exemption. Washington legislation already requires counties to give a minimum of a 10% fee reduction for storm water control facilities for any new or remodeled commercial building that utilizes a permissive rainwater harvesting system. (Additional information: www.ecy.wa.gov/programs/wr/hq/rwh.html)

Protection for Colorado Water Rights Holders

Senate Bill 08-119 would authorize the State of Colorado Division of Water Resources, in cooperation with the Colorado Water Conservation Board, to select up to 10 pilot projects throughout the state, intended to advance the understanding of how rainwater harvesting can be implemented in Colorado while protecting existing water rights. Limited to new residential and/or mixed use development, the pilot projects would allow collection of rainwater and snowmelt from rooftops and other impermeable surfaces for outdoor irrigation and fire protection. The State Engineer would establish Criteria and Guidelines for applications and the selection of pilot projects, including specific data collection requirements. Selection would be based, in part, on opportunity to collect information from a variety of geographic and hydrologic areas throughout the state. At a minimum, applicants would be required to demonstrate:

- Ability to produce a reliable water supply that can be administered by the Division of Water Resources
- Adequacy, stability, and reliability of supplemental water supplies and replacement supplies for augmentation of collected rainwater
- How the project addresses key water needs identified in the Statewide Water Supply Initiative or as identified in the basins' needs assessment
- Promotion of water conservation beyond rainwater harvesting by being paired with other water conservation methods and measures (e.g. water-wise landscaping).

Following the process currently in place for water users to replace out-of-priority diversions on an interim basis, rainwater harvesting pilot project applicants would be required to submit an annual Substitute Water Supply Plan (SWSP) to the State Engineer. The plan would detail the expected amount of precipitation to be captured, augmentation at a minimum level of 30% of the precipitation captured (the same as currently allowed for on-stream reservoirs and gravel pits under the statutory exemptions previously described), and the source and amount of the augmentation water. The SWSP would contain appropriate terms and conditions to allow proper

administration by the State Engineer and to prevent injury to vested water rights. As with all SWSP's, regular accounting and reporting would be required.

The State Engineer would present an annual report summarizing the results of the pilot projects to the Legislature. Annual application fees would be assessed to each applicant to support the costs associated with this report. At the conclusion of the 10th year of the projects, each applicant would submit a report summarizing project data collection and the State Engineer would compile and summarize the data for presentation to the Legislature.

At the conclusion of the pilot project, the applicant would have the option to either:

- Apply for a permanent augmentation plan for rainwater collection in the same manner as any water court applicant, but would be required to augment only the actual out-of-priority depletions as evidenced by the pilot project's data; or,
- File a plan with the State Engineer to permanently retire the rainwater collection system, with the plan being reviewed and approved prior to the cessation of augmentation.

Conclusions

Public interest in developing projects and water supplies with a sustainable, conservation-oriented approach is growing in Colorado and throughout the world. Rainwater harvesting could help reduce the need to take agriculture out of production to support new residential and mixed use irrigation.

Under current Colorado law, there is no incentive for residential or commercial rainwater harvesting because water users have to replace 100% of any water captured. This does not recognize the amount of water that is naturally consumed by existing vegetation at undeveloped sites. The Colorado Supreme Court has historically ruled against attempts to obtain water rights by eliminating vegetation that consumed water. However, the court indicated that it would support a "schematic and integrated system of developing this kind of water supply with control and balancing considerations".

Allowing a limited number of rainwater harvesting **pilot projects**, under the administration of a Substitute Water Supply Plan, would provide an opportunity to study the feasibility of implementing this concept in Colorado and to identify necessary terms and conditions to protect existing water rights into the future. Replacing 30% of the water captured during the pilot program would protect existing water rights and could even provide a net benefit to the stream, as estimates show that the stream historically received an average of only 3% of the precipitation and up to 15% in wet years (based on Douglas County hydrology). Data collection would allow Colorado to investigate how rainwater harvesting could be implemented, through utilizing the framework of an augmentation plan, without injuring existing water rights.

Benefits of rainwater harvesting are proven in other areas of the world. Pilot projects could be a sound way for Colorado to explore how to achieve similar benefits while protecting vested water rights.



Contact Information

This information was compiled by Beorn Courtney, P.E. of Headwaters Corporation. Ms. Courtney is a water resources engineer and was a lead investigator for the rainwater harvesting study conducted under a CWCB Water Efficiency Grant for Douglas County: *Holistic Approach to Sustainable Water Management in Northwest Douglas County*.



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