Utilizing Gray Water and Rainwater in Building Design

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All life forms on Earth must have water to survive. While there is an abundance of this precious resource on the planet, it is not necessarily located where it is needed, local raw reserves that were once thought to be more than adequate are quickly becoming depleted and the treatment of readily available water may be cost-prohibitive. Even though water-conserving fixtures are becoming mandated for new building designs and replacement work, many highly developed areas have already reached water crisis levels—as evidenced by restrictions or bans on certain uses such as landscape watering. With increasing population growth and industrialization, the use of gray water and rainwater in building designs is the next logical step towards conserving potable water.

The "green" building movement recognizes the use of rainwater and gray water as important factors contributing to overall resource use efficiency. For example, Version 2.2 of the U.S. Green Building Council LEED (Leadership in Energy and Environmental Design) Green Building Rating System offers a 1.1 point credit for a 50-percent reduction in water use for landscape irrigation and recognizes the use of gray water and rainwater as two of the strategies for obtaining the credit; the ICC 700 *National Green Building Standard* offers 4 points for every water closet flushed by recycled water and 10 points for on-site irrigation with recycled water; and the working draft 1.05 of American Society of Heating, Refrigerating and Air-Conditioning Engineers 189.1, *Standard for High-Performance Green Buildings except Low-Rise Residential Buildings*, allows the use of alternative sources such as gray water and rainwater to meet the prescriptive option for building water use reduction.

Gray Water Reuse Systems

Gray water consists of the waste flows from bathtubs, showers, lavatories, laundry tubs, clothes-washing machines and hand-washing sinks. Kitchen sink and dishwasher waste flows, often referred to as "dark gray water," are typically excluded from gray water collection systems due to high levels of organic matter and solids. Waste flows from water closets, urinals and diaper laundry are referred to as "black water."

Several generations ago, it was not uncommon in rural areas for clothes washer discharge to be routed to an obscure area on the property rather than to the septic system. However, because these waste flows did not meet strict regulatory criteria for safe surface discharge and plumbing codes required laundry waste to be connected to the sanitary drain system of the building, discharging laundry waste flow to one's own property became obsolete if not outright illegal. In areas with severe drought conditions or high water costs, however, grassroots efforts continued to explore various methods of using gray water discharge safely and efficiently. In later years, governments and water regulatory bodies recognized the impending water crisis and began funding pilot projects for larger case studies of various technologies. Numerous gray water processing and use methods with proven track records are now available.

The *International Residential Code* and *International Plumbing Code* include provisions for gray water systems. Collection of gray water from specific fixtures involves the installation of a sanitary drainage piping system that is separate from the black water sanitary drainage piping system in the building. It is then processed by filtration, settling, disinfection and/or coloring, depending on the intended end use. A non-potable water distribution system is then required to route the processed gray water to water closets, urinals or a subsurface irrigation system. Gray water reuse is straightforward in theory, but in actual practice there are challenges to making even the simplest of systems perform reliably and without undesirable effects. Local health and environmental regulations also continue to create barriers.

Is a gray water reuse system appropriate for a given building? The answer depends on a variety of considerations.

This public toilet uses reclaimed water.

- **Is there enough demand for the volume of gray water generated?** A multifamily apartment complex on a small property might generate so much gray water that most of the flow would end up in the sewage disposal system anyway, whereas a single-family residence might generate so little as to require significant potable make-up water.
- **Does the regulatory climate allow for gray water reuse either inside or outside the building?** In many areas, laws prohibit any untreated waste discharge to the environment or have such onerous requirements for testing and reporting that gray water reuse is discouraged. However, other localities actually encourage gray water reuse by offering rebates.
- **Does the capital expenditure and operating expense offer a reasonable payback period?** A residential gray water reuse system that costs $20,000 and saves $100 worth of potable water per year may not provide an appropriate payback period, whereas a $100,000 system for a large multi-tenant building that saves $5,000 of water and sewer costs per year might be appropriate.
- **Will the required system maintenance be appropriate for the type of building?** For example, a complex gray water reuse system would be too complicated for most homeowners, but probably not beyond the capability of maintenance personnel responsible for a large office or apartment building.

Rainwater Use

Rainwater has been collected for domestic use for many centuries. As modern conveniences like electricity and centralized water treatment systems came into existence, the practice became much less common. However, with the increasing lack of availability and the rise in cost of potable water, rainwater collection and distribution systems are making a strong comeback in many areas.

Rainwater has an advantage over gray water in that it generally contains fewer pollutants and is easier to collect, and there are few regulatory barriers to outdoor uses. It can also easily be treated for more uses inside a building such as showers, handwashing and even drinking. Perhaps the greatest drawback to the development of rainwater use systems is that the supply is not guaranteed. To compensate, storage volume must be significantly greater than that required for gray water. In addition, rising environmental pollution requires that rainwater be treated before storage and use for indoor purposes, and storage of rainwater intended for human contact can present problems with bacteria growth such as Legionella.

Is a rainwater storage and use system appropriate? Consider the following questions.

- **Is there enough average annual rainfall to meet the demands of the intended use?** Installation of a rainwater harvesting system might not make any practical sense in a consistently arid climate.
- **Do regulations allow rainwater to be collected for use?** Collection of rainwater may be prohibited by local laws because it is needed to replenish reservoirs and aquifers.
- **Do the capital expenditure and operating expenses offer a reasonable payback period?** As with a gray water reuse system, the costs of a rainwater storage and use system should make reasonable economic sense.
- **Can the system easily and consistently be maintained to provide nearly potable water conditions?** Keeping large volumes of stored water in a near potable condition might prove to be difficult.

Conclusion

There is clearly a movement toward embracing the concept of water reuse. Gray water treatment technologies are quickly improving to become more reliable and easier to maintain, indoor rainwater use systems are being reinvented even as we speak, and state and local regulatory agencies are beginning to reevaluate and change old regulations. As potable water costs continue to rise and the availability of raw water resources for centralized treatment grow progressively scarcer, gray water reuse and rainwater harvesting will continue to be integrated into homes and buildings. ◆