BY WINSTON HUFF, CPD, LEED AP

Using On-site Systems to Help Offset Combined Sewer Overflows

More than 770 communities across the country are implementing long-term control plans to meet the U.S. Environmental Protection Agency's requirement to reduce the number of combined sewer overflows (CSO). Most communities with CSOs are located in the Northeast and Great Lakes regions and the Pacific Northwest (see Figure 1), affecting approximately 40 million people. The long-term control plans include green solutions such as rainwater harvesting systems in commercial buildings. Plumbing engineers will definitely be part of developing design solutions to control this problem.

Unfortunately, the control plans are costing large amounts of money to implement. For example, in New York City the Bloomberg administration is set to commit $2.4 billion in public and private investment to applying new environmental technologies. Other cities in the country are spending more than $1 billion. The New York State Department of Environmental Conservation has tentatively assented to a proposal by the city to introduce infrastructure to retain storm water before it reaches the sewer system and overloads it. This approach reflects a shift from traditional sewage-control methods such as underground storage tanks and tunnel systems to techniques like rainwater harvesting systems.

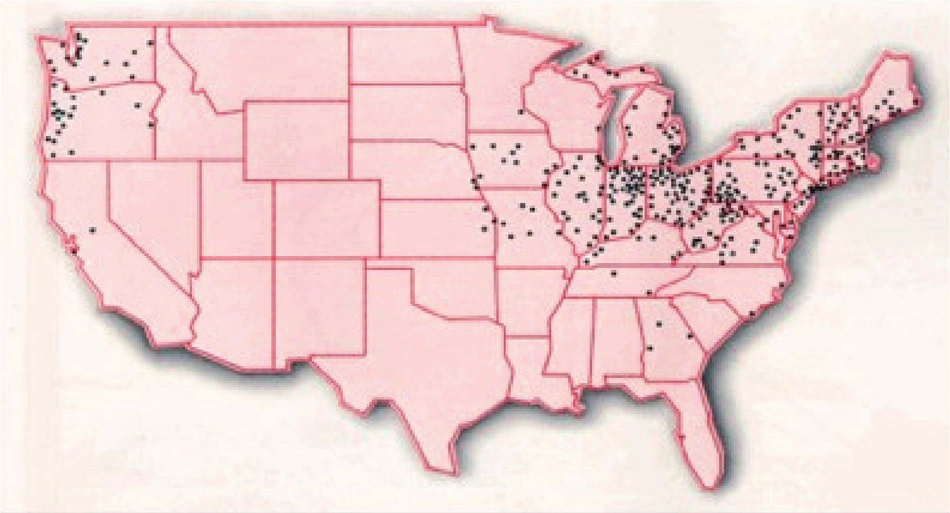


Figure 1 Combined sewer overflow demographics
Source: U.S. Environmental Protection Agency

The U.S. EPA promotes these newer forms of infrastructure as a cost-effective and environmentally preferable alternative to conventional overflow management. Sewer overflows can be the biggest water-quality problem for some communities and are preventing area waterways from meeting federal standards for fishing, swimming, and healthy habitats for wildlife. For instance, in New York City each year up to 30 billion gallons of overflow enter New York Harbor, Jamaica Bay, Newtown Creek, and other waterways.

Some communities are looking at imposing requirements for residential and commercial developments that limit the amount of runoff allowed from a new project to hopefully promote the installation of sustainable systems in buildings—systems that will be designed by plumbing engineers. Cities expect that these actions will improve quality of life, reduce sewage overflows, and cut the cost of sewer management, which will help keep utility costs down.

WHAT IS A CSO?

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where the wastewater is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called combined sewer overflows (CSOs), contain not only storm water, but also untreated human and industrial waste, toxic materials, and debris. In some areas, 1 inch of rainfall can cause the systems to overflow.

Many methods have been utilized to address this problem, often involving improvements in the municipal system off site from the building. One way was to increase the capacity of the wastewater treatment facility to handle the volume of wastewater and storm water. This solution can be very costly, and in many cases it isn't possible to increase the size of the main piping to handle the added volume. Other methods include building tunnels and large holding tanks in the system, but these are very costly to construct and maintain. In the past, these issues were the responsibility of the municipal or site civil engineer and usually did not affect the design of the building. In many areas, the plumbing engineer is responsible for systems within the building and 5 feet outside the building. Water flowing beyond that point is the responsibility of someone else.

The current effort is different because it encourages on-site systems to reduce the amount of storm water flowing into the municipal system. Some of the design responsibility is moving away from the municipal and site civil engineer to the plumbing engineer because these systems are in the footprint of the building.

ON-SITE SYSTEMS

The U.S. EPA is encouraging new green systems off site such as permeable paving, rain gardens, and storm water retention areas in public parks, but many on-site options are available to plumbing engineers.

Green Roofs

The U.S. EPA has evaluated green roofs as a storm water management tool by comparing runoff quantity and quality from green and flat asphalt roofs. The influence of media type, media depth, and drought during plant establishment on plant growth and long-term management of media pH also were investigated. The goal of the project was to provide high-quality replicated data that could be used to develop and refine reliable anticipated runoff volumes and loadings from green roofs, as well as to evaluate factors that impact plant growth and establishment. Results indicate that green roofs are capable of removing 50 percent of the annual rainfall volume from a roof through retention and evapotranspiration. (You can download the entire report at epa.gov/nrmrl/pubs/600r09026/600r09026.pdf.)

Green roofs can change the design of the plumbing system in a building. Some green roofs are complete packaged systems that provide the green roof drainage and roof drain connection. This will require close coordination with local building code authorities to verify rainwater leader and roof drain sizing. While the green roof can retain water and slow the flow of water from the roof to the external piping system, sizing the building rainwater leaders should take into consideration the absence of a green roof, since a future building owner may decide to change the roof from a green roof to a hard surface.

Some green roofs will require irrigation systems at least until the plants are established. The irrigation system will need a water connection with a backflow preventer.

> Reducing the flow at the source is complicated, but it is less complicated than pushing the problem downstream for the municipal system to handle.

Rainwater Harvesting

In most cases, a rainwater harvesting system intercepts, diverts, stores, and releases rainfall for future use. Rainwater that falls on a rooftop is collected and conveyed into an above- or belowground storage tank where it can be used for non-potable water uses and on-site storm water disposal and infiltration.

Nonpotable uses for rainwater may include:

- Toilet and urinal flushing
- Landscape irrigation
- Exterior washing (e.g., washing cars, building facades, sidewalks, streets)
- Chilled water cooling tower makeup
- Laundry

These systems can be a simple rain barrel at the end of a downspout, or they can be very complex systems that can provide the entire domestic and fire protection water requirements for a building.

Many resources on how to size, design, install, and maintain a rainwater system are available. For instance, the U.S. EPA's *Municipal Handbook* addresses harvesting principles, designs, example code requirements, policies, and incentives to implementing a municipal rainwater harvesting program, such as reducing storm water runoff, conserving potable water, and providing environmental and economic benefits. Barriers to implementation also are addressed, and case studies from across the country demonstrate successful rainwater harvesting programs. It can be downloaded at epa.gov/npdes/pubs/gi_munichandbook_harvesting.pdf.

Local and regional regulatory agencies are developing new standards and guidelines for rainwater harvesting systems, but these requirements vary widely. For example, some areas in Washington State allow rainwater systems to be used as the primary water service for residences, but other areas may not allow rainwater use inside a building. The first step is to coordinate the system with the local water, waste, and storm water authorities. Then go to the health and building code authorities and make sure that they will approve the system.

The term "water quality" also can have different meanings depending on locality. This begins on the roof. For instance, the pH of rainfall in the eastern United States tends to be acidic (ranging from 4.5 to 5), which may result in the leaching of metals from the roof surface, tank lining, or water laterals to interior connections. Because of this some codes require a submittal showing that the materials in the system are safe to use. Once rainfall leaves rooftop surfaces, pH levels tend to be slightly higher, ranging from 5.5 to 6. The quality of the water must be maintained when the water is stored, so limestone or other materials may be added in the tank to buffer acidity, if desired.

The incoming water also can be filtered to reduce contaminants. If the water is used in the building for plumbing fixtures, it may need chlorination and particulate filters to keep flush valves from clogging. The water should not smell or have odd colors in the bowl of the fixture.

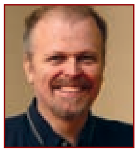
Rainwater systems will require overflow systems that must be designed with an overflow mechanism to divert runoff when the storage tanks are full. From the municipality perspective, overflows should discharge to pervious areas set back from buildings and paved surfaces or to secondary BMPs. However, this storm water practice can conflict with building plumbing code requirements. One issue can be chlorine in the water. If chlorine is used, what will happen if it is mixed with the overflow water and flows out to a natural area?

The plumbing engineer should coordinate with the site designer when considering secondary runoff reduction. The filter path is a pervious or grass corridor that extends from the overflow to the next runoff reduction practice, the street, an adequate existing or proposed channel, or the storm drain system. In many cases, rainwater harvesting system overflows are directed to a secondary runoff reduction practice to boost overall runoff reduction rates.

When rainwater harvesting systems are used to offset CSO requirements, some design objectives must be followed. For example, in some cases a storm water credit is available only for dedicated year-round drawdown/demand for the water. While seasonal practices (such as irrigation) may be incorporated in the site design, they are not considered as contributing to the treatment volume credit (for storm water purposes) unless a drawdown at an equal or greater rate is also realized during non-seasonal periods (e.g., treatment in a secondary runoff reduction practice during non-irrigation months).

CONCLUSION

Combined sewer overflows are a serious problem that should be handled, but this is not a simple problem to address. Solving the problem at the municipal level is part of the solution. The other part of the solution is looking further upstream to the individual parcels and buildings. Reducing the flow at the source is complicated, but it is less complicated than pushing the problem downstream for the municipal system to handle. Ultimately, the plumbing engineer will be responsible for finding solutions to help with CSO problems.



Winston Huff, CPD, LEED AP, is a project manager, plumbing fire protection designer, and sustainable coordinator with Smith Seckman Reid Consulting Engineers in Nashville, Tenn. He is on the U.S. Green Building Council's Water Efficiency (WE) Technical Advisory Group (TAG). He was the founding editor of Life Support and Biosphere Science and has served as its editor-in-chief. He is editor of Me Green You Green (megreenyougreen.com), a LEED credit data bank. For more information or to comment on this article, e-mail **articles@psdmagazine.org**.