RAIN BARRELS – TRUTH OR CONSEQUENCES

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Abstract

Rain barrels are a centuries-old technique used by many cultures to collect rainwater from rooftops for later use or consumption. Recently, rain barrels have become popular in parts of the United States and Canada for a variety of uses, particularly among "green" proponents. Their uses may include garden and lawn watering (particularly during drought conditions), and even possible combined sewer overflow volume (CSO) reduction. In addition to the logistical and cost issues surrounding the use of rain barrels, proponents boast the right to a "free" resource on the grounds of environmental ethics. Although there are many potential benefits, there are a number of factors that sponsoring agencies must consider before embarking on a rain barrel program. The Milwaukee Metropolitan Sewerage District (MMSD) will begin advocating for and implementing such a rain barrel program. While considering whether to pursue rain barrels, staff worked to quantify the potential benefits to CSO reduction. No CSO volume reductions were demonstrated, but treatment cost reductions *were* realized. Therefore, a program to subsidize, distribute, and educate people about how to use rain barrels will be crafted and launched by the MMSD.

This paper describes rain barrels and how they work. It also explores how well rain barrels perform against some of the benefit assumptions, including water quality issues not generally discussed in this context. This paper also compiles a list of assumptions and suggestions for their use that encompasses barrel size and shape, key barrel features, climate considerations, algae and mosquito control, and home foundation protection, among other issues. It will explore these issues from a neutral position, with the end result being a recommendation for or against the use of rain barrels in the MMSD service area—a recommendation that may be applied by other sewerage agencies looking to reduce treatment costs while also reaping other environmental benefits.

Introduction

Rain barrels are on-site rainwater collection systems. Rainwater can be collected as a valuable resource for lawn and garden watering, as well as possibly retained to reduce CSO volume and storm water management costs. Implementing a rain barrel program first requires an evaluation of the potential to meet desired results. The Milwaukee Metropolitan Sewerage District (MMSD) has studied the effectiveness and benefits of such a program, and is in the early stages of crafting and eventually implementing it. Aspects of that evaluation and factors to be considered during implementation are described below.

Program Function

There are a number of factors to consider before implementing a rainbarrel distribution program. These include setting goals for the program, educating the user public about how to operate and care for rainbarrels, and being realistic about the benefits. While a potential program for the Milwaukee region may produce only modest results, there are side-benefits to be gained, such as educating people and getting them involved in possibly reducing the volume of CSOs. The effectiveness of any potential program could be enhanced through promoting an integrated management plan featuring compatible stormwater management concepts, including things like downspout disconnections, green roofs, raingardens, and grassy swales. In

fact, this is the direction to be taken by the MMSD. While some rainbarrel users also use the rainwater for drinking, the MMSD will not likely recommend this use (see below).

Uses

Recently, rain barrels have become popular in parts of the United States and Canada for a variety of uses, particularly among "green" proponents. Their uses may include garden and lawn watering (particularly during drought conditions) or even CSO reduction. In addition to the practical and cost issues surrounding their usage, rain barrel proponents boast the right to a "free" natural resource on the grounds of environmental ethics.

Although there are many potential benefits, there are a number of factors sewerage agencies must consider before embarking on a rain barrel program. These include water quality issues, climate considerations, algae and mosquito control, physical site suitability, homeowner ability and willingness to operate effectively, and home foundation protection.

Water Quality. Rainwater collected in a barrel can provide a relatively clean, safe, and reliable source of water as long as the collection system is properly built and maintained. Rainwater that is to be used outside to water lawns or gardens is typically not a water quality concern. The roof construction materials should not be treated cedar shakes or materials containing asbestos. The gutter system should not have lead solder or lead-based paint, and bird droppings should be cleaned from gutters and the roof as needed. Depending on the location, an awareness of the dry deposition of pollutants from the air may also be warranted. Overall, rain barrel water quality is not a major concern unless the water is intended to be consumed. Filtration and disinfection would be necessary for consumption-based water use, and is beyond the scope of this analysis.

Climate. Climate considerations apply particularly where temperatures regularly reach freezing during winter months. Where this occurs, rainbarrels should be disconnected during winter months to ensure that water in rainbarrels doesn't freeze and damage barrels and/or allow water to back up into downspouts or overflow into building foundations. When rainbarrels are disconnected for winter months, they should be stored upside down so they may fully drain and remain relatively clean. During this time, downspouts should be reattached so that winter precipitation doesn't damage foundations. In the Milwaukee, Wisconsin region, CSOs occur an average of 2.5 times per year. These have occurred overwhelmingly during non-winter months and, when they do occur in winter, are typically due to mechanical malfunction. Therefore, disconnecting rainbarrels in the winter will not likely reduce the effectiveness of rainbarrels as a CSO volume reduction approach.

Algae. Algae are microscopic, photosynthetic plants. When exposed to sunlight, chlorophyll in algae converts carbon dioxide (CO_2) and water into glucose and oxygen (O_2). Generally, algal growth in water is influenced primarily by the amount of nutrients (phosphorus, nitrogen, carbon, etc.) in water, and secondarily by the availability of light incident on the water. However, water temperature, water flow, available substrate, and pH also influence the growth of algae.

The primary factor controlling algal growth--nutrient content in water--generally comes from leaves, lawn clippings, fertilizer, pet waste, and non-contact cooling water that enter the water cycle *after* water is discharged from a rainbarrel. It would follow, therefore, that the nutrient content of rainbarrel water is not likely to be high, and may not be a large determinant in rainbarrel algae growth. Intuitively, there are exceptions to this: (1) rainbarrels that collect runoff from a green roof or rooftop garden and (2) rain gutters

that are filled with leaves, allowing rainwater to filter through. Raingardens remain rare in the Midwestern U.S., and the problem of leaves in the gutter is easily avoided by periodic cleaning to reduce this primary influence.

The secondary factor controlling algal growth is light. Light incident upon standing water in a rainbarrel is a function of rainbarrel design. Rainbarrels with open or screened tops or that allow light to penetrate will provide more light inside the barrels. Therefore, open and/or light colored rainbarrels would be more likely to contribute to algal growth. On the other hand, rainbarrels with openings limited to the size of the downspout or gutter tube would allow less light to reach water stored inside. Therefore, partially closed and/or darker rainbarrels would be less likely to contribute to algal growth.

Other factors listed above include water temperature, flow, and pH. Water temperature may be relatively high when rainbarrels are placed in full sun, thus increasing the risk of algal growth. Placing rainbarrels in shade can reduce this risk. Flow is virtually nonexistent, thus further increasing the overall risk of algal growth. Overall pH can be affected by roofing materials, and higher pH levels contribute to algal growth. Rainwater typically has a slightly lower pH and, therefore, higher pH is not likely an issue. Further study of this is suggested.

There are a number of factors, such as low nutrients, that tend to minimize algae growth. Other factors, such as incident light and water temperature, can be managed to further minimize (but not eliminate) the potential for algae growth. While algae is typically considered undesirable, small amounts of algae that may grow in a rainbarrel may actually help to fertilize gardens and lawns. Given that some causal factors are not favorable and that others may be minimized, algae growth in rainbarrels can be kept in check by selection of barrel characteristics that limit algal growth and proper barrel placement.

Mosquitoes. West Nile virus is increasingly becoming a concern in the Midwest, as an increasing number of illnesses and deaths are blamed on the virus. Mosquitoes tend to breed in wet areas, and the *Culex* mosquito that carries and transmits West Nile virus is found where there is decaying organic matter and wet conditions. Recommendations to reduce populations of *Culex* mosquitoes include source reduction of mosquito breeding sites and avoidance of biting mosquitoes. Recommendations for reducing breeding sites include eliminating or emptying artificial water collection containers described as "prime breeding spots for the mosquito species implicated in the transmission of West Nile Virus." (See: http://www.cfe.cornell.edu/erap/). This potential connection between standing water breeding sites and rainbarrels may have implications for rain barrel use. Mosquitoes can breed in as little as 10 days. In rainbarrels that allow mosquitoes to enter, therefore, rainbarrels should be emptied in less than 10 days. Another potential solution is to screen the rainwater inlet so mosquitoes don't enter in the first place. In either case, user education is key to reducing the potential for *Culex* mosquito breeding sites.

Physical Site Suitability. Homeowners--rather than professionals--typically install rainbarrels, so it is very important that any distribution program make homeowners aware of the risk to their home foundations. Because water pooling near a foundation can eventually work its way into a home's basement, it's important to make sure the collection system keeps water away from the foundation. This includes properly channeling water from the inlet to the rainbarrel, provisions for rainbarrel overflow during larger storms, and drip-free spouts and hose connections. This also involves instructions on how to reattach downspout connections prior to winter months. With proper care, foundation and basement damage can be avoided.

There are some situations where rainbarrels may not be appropriate. These include high-density urban settings where there may not be a significant use for the collected water. Moreover, homes that are close together may not have an adequate area to contain rainbarrel overflow. Such homes in Milwaukee are more likely to be located within the combined sewer service area and, therefore, should be carefully evaluated, particularly when disconnecting direct downspouts to the combined sewer. Finally, where homes are located on smaller lots, there may be less opportunity for garden watering simply due to space constraints.

Homeowner Willingness and Ability. Proper care includes a willingness on the part of the homeowner to periodically check to see that connections and fittings are in proper working order, empty the barrel after a rainstorm (in advance of new rainstorms), remove the barrel and store it for winter, and reconnect the downspout. Some homeowners may see this work as bothersome, and still others may not be physically capable of performing the work. To have or not to have a rainbarrel is an individual decision. Incentive and assistance programs could be developed to encourage rain barrel use and proper maintenance.

CSO Volume Reductions

The MMSD has responsibility for sewage conveyance and treatment as well as for flood management. MMSD's sewerage system includes a regional collection/conveyance system and two wastewater treatment plants. In the late 1970s and early 1980s, MMSD undertook a Water Pollution Abatement Program (WPAP), which included over $2 billion in improvements to the conveyance system, treatment plants, and an inline storage system known as the "deep tunnel." Together, projects from the WPAP virtually eliminated separate sanitary overflows (SSOs) and reduced combined sewer overflows to an average of 2.5 times per year.

While the SSO and CSO goals of the WPAP were attained, the media and the public expect MMSD to further reduce CSO volumes. With this in mind, MMSD conducted an evaluation of a program that would utilize rain barrels in the combined sewer system area to reduce the volume of stormwater runoff. The study assumed 40,000 single-family homes in the combined sewer service area. Each home was estimated to have 1,200 square feet of roof area that emptied into two 90-gallon rain barrels, each collecting rainwater from 600 square feet of roof. Homeowners were assumed to empty the rain barrels after each storm event and the water would be released to infiltrate into the ground and not into the combined sewer system. An analysis of the precipitation record from 1940 to 1997 showed the following results:

Number of events:	78.2
Mean Volume:	0.40 inch
Median Volume:	0.19 inch
Mean Duration:	15.1 hours
Median Duration:	9 hours

The distribution of the storm events show half of all events are 0.19 inch or less, but we found that these events account for only 8.5 percent of the total rainfall volume. A 90-gallon rain barrel can hold 0.24 inch of rainfall from a 600 square foot roof. The annual capture amount from the 40,000 residences using two 90-gallon barrels was calculated to be 243 million gallons. With proper disposal, this volume represents water flow that would not need to be treated at the treatment plants. Most storm events that are 0.24 inch or less do not typically result in a CSO event. In fact, these relatively small storms with low rainfall volume are easily conveyed to the treatment plants. Even in a large storm the rain barrel volume collected in the beginning of the storm would not reduce the volume of a CSO, which happens much later in the storm. The study showed that an extensive rain barrel program would not have an impact on CSOs but that such a

program could reduce costs at the treatment plants. Further research is needed to determine if rain barrels used in conjunction with other on-lot treatments (rain gardens, storm water trees, boulevard swales, etc.) could be integrated to decrease runoff volumes enough to reduce the volume of a CSOs. While none of these other on-lot treatment programs may make a significant impact as a stand-alone solution, in combination there would likely be a greater benefit.

Recommendations

An extensive rainbarrel distribution and use program may not provide reduction in CSO volumes, but would save treatment costs at the plants. There are a number of considerations that program sponsors must take into consideration before sponsoring a distribution program. These include:

- A realistic understanding of the goals to be met
- A public education program that includes the benefits, costs, and considerations of rainbarrels
- The likely need to provide technical assistance to homeowners

Likewise, homeowners must take into consideration a number of factors before deciding whether to become rainbarrel owners. These include:

- An understanding of how to operate rainbarrels, including the need to drain them within a reasonable period after a rainstorm
- A physical ability and personal commitment to operating rainbarrels as recommended

Conclusion

There are a number of factors to consider before implementing a rainbarrel distribution program. These include setting goals for the program, educating the user public about how to operate and care for rainbarrels, and being realistic about the benefits. While a potential program for the Milwaukee region will produce only modest benefits, there are additional benefits to be gained by getting people involved in reducing treatment costs and by educating them in the process. And, the effectiveness of any potential program could be enhanced through promoting an integrated management plan that also promotes compatible stormwater management concepts, including things like green roofs, raingardens, storm water trees and grassy swales.