Evaluating the Stormwater Mitigation Potential of Living Wall Systems

Ostendorf, M.[1], K. Thompson[1], M. Woolbright[2], S. Morgan[1], S. Celik[1], and W. Retzlaff[1]

Southern Illinois University Edwardsville[1], Green Wall Ventures[2]

ABSTRACT

Eighteen circular (7-foot diameter) green retaining walls have been located on the SIUE campus. Walls are arranged in a completely randomized design, utilizing five *Sedum* treatments and one unvegetated control. The project is designed to evaluate the capacity of green wall systems to reduce stormwater runoff and to mitigate urban flooding. In a preliminary stormwater saturation test, we determined that a planted wall produced a delay in runoff of approximately 20 minutes in comparison to an unvegetated wall. This delay appears to be present in the emerging data, particularly following intense rain events. For total stormwater runoff, data collected so far indicates that walls planted with *Sedum (Phedimus) takesimensis* produce the least amount of stormwater runoff while unplanted control walls and walls planted with *Sedum spurium* produce the most runoff. Our evaluation so far indicates that living wall systems have the potential to reduce storm water runoff.

INTRODUCTION

As cities expand to accommodate rising populations, the addition of buildings, highways, and parking lots is inevitable. But the influx of impervious surfaces deters natural stormwater infiltration, which can increase the potential for urban flooding (VanWoert et al., 2005). Stormwater best management practices (BMPs) are often put in place to mitigate flooding by retaining or detaining stormwater runoff. However, finding land to dedicate solely to common stormwater BMPs, like retention ponds, is difficult and costly in urbanized watersheds. Thus, systems that serve multiple functions have become desirable (Carter & Jackson, 2007). Innovative stormwater management tools have emerged to address the issues of cost, space, and even aesthetics for metropolitan areas. Tools like rain gardens, green roofs, and green walls are designed to encourage infiltration and evapotranspiration while reducing or delaying runoff.

Green walls can be employed on building facades or along hilly urban terrain as retaining wall systems. In comparison to other green technologies, green walls have not received sufficient study. The purpose of my study is to evaluate the potential for green retaining walls, installed on the SIUE campus, to mitigate stormwater runoff. Stormwater retention volumes for planted and unplanted retaining walls are being evaluated. It is hypothesized that stormwater runoff for planted walls will be less than for unplanted walls.

Figure 1. Each wall system is designed with an underlying impervious base layer (top) to direct stormwater through a central water outlet and into stormwater collection units (bottom).

Figure 2. Eighteen circular living wall systems are being evaluated (left). *Sedum* species are planted in every pocket and on the top of each wall system for vegetated treatments (right).

MATERIALS AND METHODS

Eighteen green retaining wall systems with five vegetated treatments and an unplanted control, with three replicates of each, were arranged in a completely randomized design. Green wall systems were constructed on the SIUE campus in 2007. Each 7-foot diameter wall utilizes patented green wall blocks, donated by Hercules Manufacturing of St. Louis (Retzlaff et al., 2008). The core of each wall was filled with bottom ash donated by Ameren UE. Bottom Ash (80% by volume) blended with composted pinebark (20% by volume) was applied to the pocket of each block and along the top surface of each wall at 2 in. depth. Green walls, aside from the controls, were planted on July 1, 2007 with one of the following: *Sedum hybridum 'Immergrauch', Sedum kamtschaticum, Sedum (Phedimus) takesimensis, and Sedum spurium.* The mixed Sedum wall was planted with *S. spurium, S. sexangulare, S. cauticola, S.kamtschaticum,* and *S. album.*

Stormwater Retention Monitoring – Each green wall was constructed over an impervious base layer with a single stormwater outlet (Fig. 1), which is piped into a 5-gallon collection container. Stormwater runoff is measured promptly following precipitation events. Following intense precipitation, multiple measurements for several days following the event are necessary. Following multiple measurements a total stormwater volume is calculated. Stormwater data is used in reference to daily precipitation data collected by the SIUE Waste Water Treatment Plant, according to National Weather Service guidelines. A one-way ANOVA for a completely randomized design is being used to test for differences between treatments. A Tukey's post-hoc test is then used to rank differences at an alpha level of 0.05 (Proc GLM, SAS version 9.1).

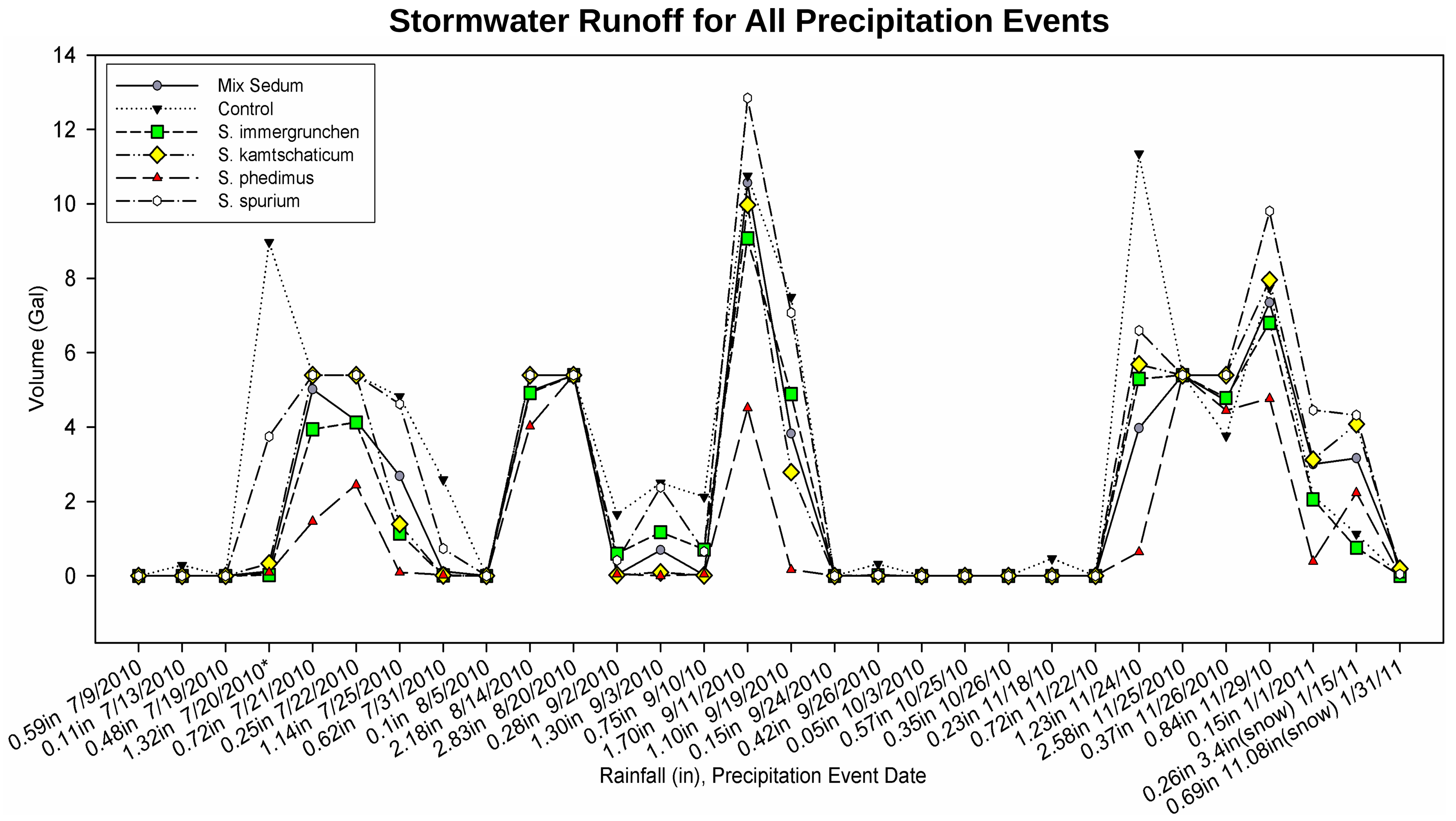

Figure 3. Mean runoff volume collected per event from 7/9/10-1/31/11.

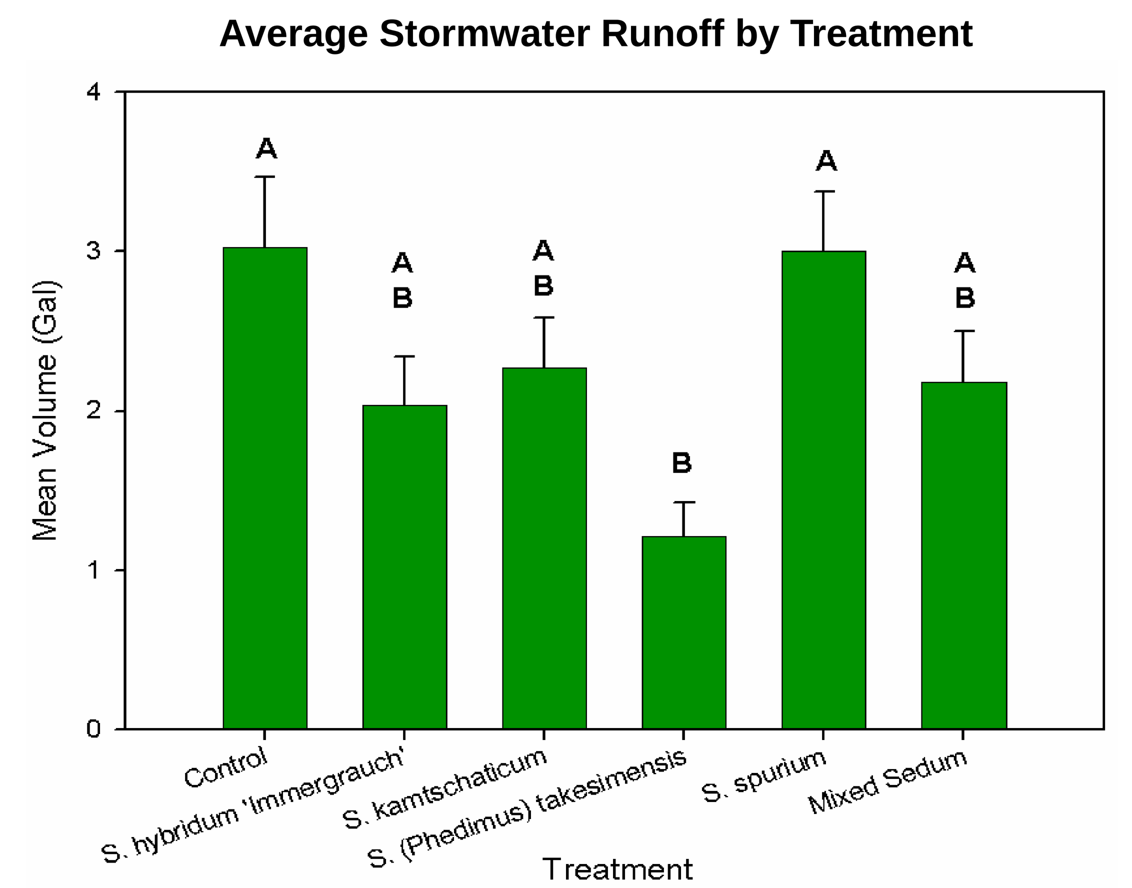

Figure 4. Mean runoff volume collected for all rain events occurring from 7/10 through 1/11. Treatments with different grouping letters are statistically different from one another (α< 0.05).

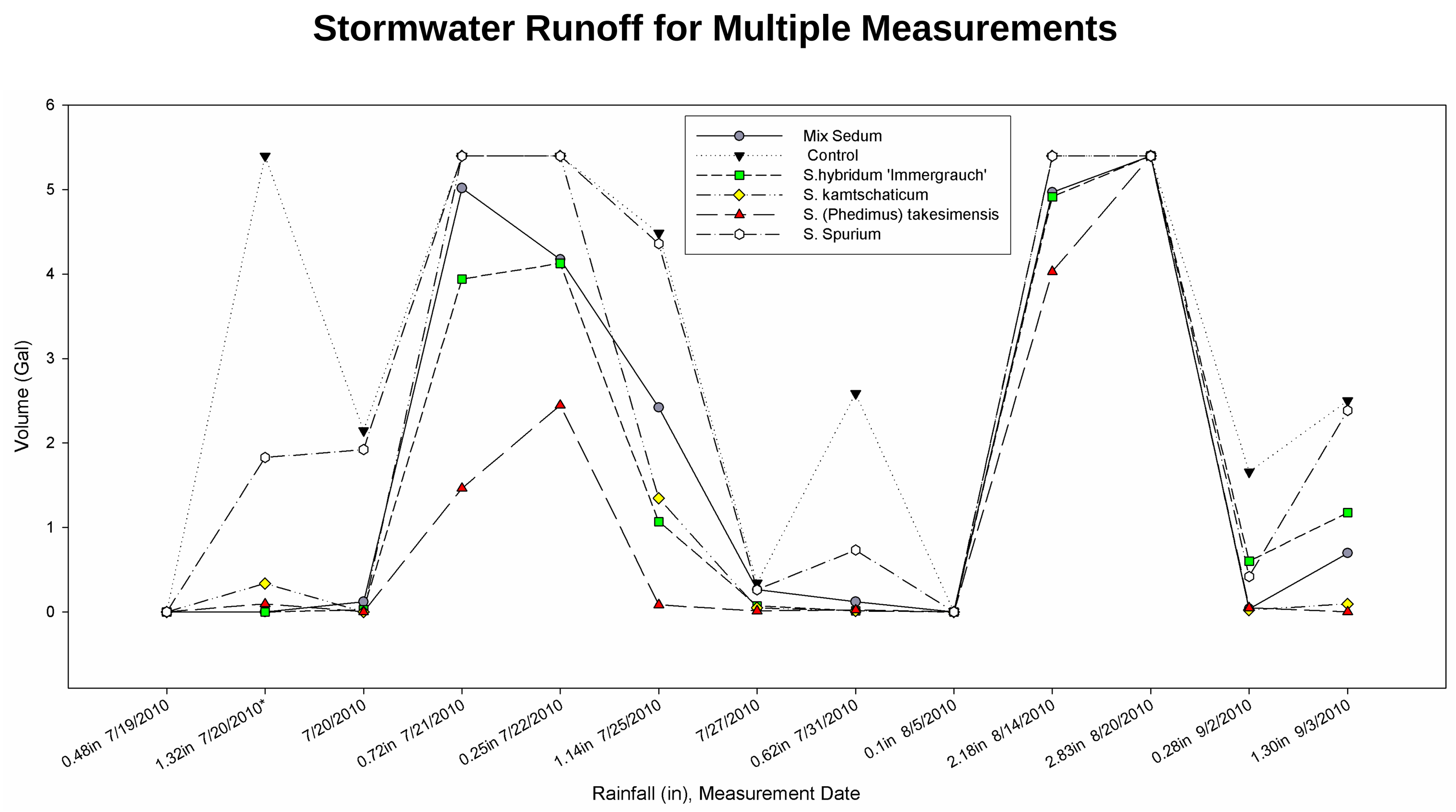

Figure 5. Mean runoff volume collected per measurement taken from 7/19/10-9/3/10.

RESULTS AND DISCUSSION

Figure 3 depicts the volume of runoff collected for individual precipitation events recorded so far. The figure illustrates ongoing measurements of stormwater runoff, which may vary depending on precipitation event duration, intensity, and frequency. The comparison of each treatment for rain events from July 2010 through Januray 2011 indicates that green walls planted with *S. (Phedimus) takesimensis* produce the least amount of stormwater runoff while unplanted control walls and walls planted with *S. spurium* produce the most runoff (Figure 4). Furthermore, rainy periods seem to promote varying responses from each treatment (Figure 5). The control walls seem to produce runoff faster than planted walls for frequent, intense rain events. Potentially, when the vegetated green wall systems are saturated, there may be a delay effect due to the interception of stormwater.

Data collection and analysis is ongoing. The anticipated outcome will be more conclusive results regarding the stormwater mitigation benefits of green wall systems. The reduction of urban storm water runoff by disconnecting impervious surfaces is desired (Mueller and Thompson, 2009). For substantial rain events, a delay in the onset of runoff between planted and unplanted systems is also desired, as shown in a green roof study by VanWoert et al. (2005).

REFERENCES:

Carter, T. and C.R. Jackson, 2007. Vegetated roofs for stormwater management at multiple spatial scales. Landscape and Urban Planning. 80: 84-94.

Mueller, G., and A. Thompson, October 2009. The Ability of Urban Residential Lawns to Disconnect Impervious Area from Municipal Sewer Systems. Journal of the American Water Resources Association. 45(5): 1116-1126.

Retzlaff, W., J. Middleton, M. Woolbright, V. Jost, S. Morgan, and K. Luckett., 2008. Evaluating the Performance of the Ecoworks Living Wall System. Proceedings Sixth Annual Greening Rooftops for Sustainable Communities Conference, Awards, and Trade Show (available www.greenroofs.org) Baltimore, MD.

VanWoert, N., D. Rowe, J. Andresen, C. Rugh, R. Fernandez and L. Xiao, 2005. Green Roof Stormwater Retention: Effects of Roof Surface, Slope and Media Depth. Journal of Environmental Quality. 34: 1036-1044.