Using Regenerative Stormwater Conveyance Systems to Restore Stream Channels and Create Habitat

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Introduction
The District Department of the Environment (DDOE) has installed four regenerative stormwater conveyances systems (RSCs) in the District of Columbia and is planning the installation of others. RSCs are open-channel, sand seepage filtering systems that utilize a series of shallow aquatic pools, riffle-weir grade controls, native vegetation and an underlying sand channel to slow stormwater velocities, infiltrate stormwater, recharge groundwater, and treat pollutants through chemical and biological processes. RSCs also reduce erosive forces on the banks of the streams where they are installed and positively impact the ecology of an outfall area by creating conditions favorable to aquatic macroinvertebrates and other wildlife. In urban areas such as the District, there is a legacy of hundreds of highly eroded first-order ephemeral tributaries, predominantly fed by stormwater runoff. These gullies can be over 20 feet deep, have little or no aquatic life, and pose significant safety and stability hazards to adjacent areas. RSCs have the potential to address this situation in a cost-effective manner as well as provide significant water quality improvement in receiving waters.

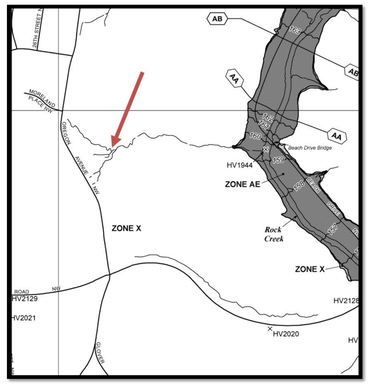

Figure 1. Project area from FEMA Flood Insurance Rate Map

Table 1. Spring bird migration species at Milkhouse Run (3/15/12 – 5/10/12)

American robin	91
European starling	10
Pileated woodpecker	8
Mallard	11
Blue-gray gnatcatcher	16
Baltimore oriole	3
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52 species in total	371

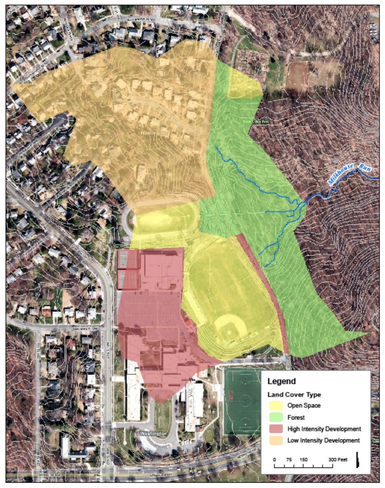

Figure 2. Project area land use and land cover map

The Value of RSCs in the District of Columbia (and Other Urban Areas)
DDOE believes that RSCs can be an important tool in our restoration toolbox for several reasons, including the following:

- RSCs can restore a stream channel and control stormwater volumes without requiring the permission and input of multiple landholders, unlike low impact development (LID) technologies such as bioretention, which are disperse and require a great deal of coordination
- RSCs are favored by the National Park Service, which manages much of the riparian lands in the District, because unlike natural stream channel design, RSCs do not require grading back stream banks and removing numerous trees
- RSCs help stabilize degrading stream valleys, dissipating energy from high-velocity stormwater flows with riffles and pools which also provide habitat that supports a variety of aquatic life
- RSCs infiltrate stormwater, thereby raising the elevation of the groundwater table and transforming intermittent and ephemeral streams into streams with baseflow year-round
- RSCs are cost effective, providing a water quality benefit equal to that afforded by a large number of LID retrofits (see Table 2)

Case Study - Milkhouse Run
In late 2010, DDOE (through their contractors, Biohabitats and Underwood and Associates) installed two RSCs on NPS property in Rock Creek Park. One of the RSCs attenuates stormwater flows from the Milkhouse Run watershed, a total of 36 acres in size, 5.4 acres of which is impervious (15%).

The project area was chosen because of the clearly degraded nature of its tributaries; because of the interest and willingness of the National Park Service to utilize this restoration technique; and as a demonstration to show the potential of these systems to address stream downcutting and habitat loss caused by uncontrolled stormwater.

One of the Milkhouse Run tributaries had downcut 12 to 15 feet in places over the past 60 years, with an estimated cumulative soil loss of 8,000 tons (average of 133 tons per year). The timeframe was estimated based on the date of installation of the sewer line, taken from historical engineering plans.

Table 2: Comparison of RSCs and LID for the Milkhouse Run Watershed

Facility Type	Cubic Feet Treated	Cost
RSC	128,589	$660,000
Roadside Bioretention	128,589	$3,860,000[1]

Figure 4. Officials examine the sewer line prior to restoration

Figure 5. An NPS official examining a downcut tributary at Milkhouse Run

Future Research Needs
To be clear, installing RSCs does not replace the need to retrofit contributing watersheds with stormwater controls. Instead, they stabilize the streams according to their current flow regime, much as natural channel design does. Installing an RSC provides habitat and water quality benefits (treating the symptoms of stormwater pollution), thereby buying time for retrofitting the watershed with stormwater controls (treating the ultimate cause of degradation).

While RSCs also have characteristics of stormwater treatment devices such as slowing stormwater velocities, infiltrating stormwater, recharging groundwater, and treating pollutants through chemical and biological processes, they are arguably not an in-stream stormwater treatment device. Instead they provide additional reasons why RSCs are a useful tool for urban stream restoration.

DDOE agrees that more research needs to be done to validate RSCs as a stream restoration technique. Some questions include the following:

- Are RSCs as effective in the Piedmont and mountain regions as they are in the coastal plain?
- How well do RSCs perform at stream stabilization compared with NSCD?
- Do RSCs restore aquatic habitat as effectively as they appear to?
- How effective are RSCs at reducing nutrient and sediment loads?
- How well do RSCs increase groundwater recharge, baseflow and wetland habitat?

To this end DDOE has committed to performing research to determine the efficacy of RSCs. DDOE has recently begun pre-monitoring and design for a restoration site in the Soapstone Run watershed of Rock Creek. DDOE has committed to monitoring nitrogen, phosphorous, and sediment loading and is considering adding components to monitor groundwater, stormflow hydrographs, macroinvertebrates, and wetland delineation.

References
[1]Schuler, Tom et al. *Urban Stormwater Practices, Version 1.0.* U.S. Environmental Protection Agency, Washington, D.C., July 2007.
[2]Rosgen, David; "A Geomorphical Approach to Restoration of Incised Rivers." Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision, 1997.

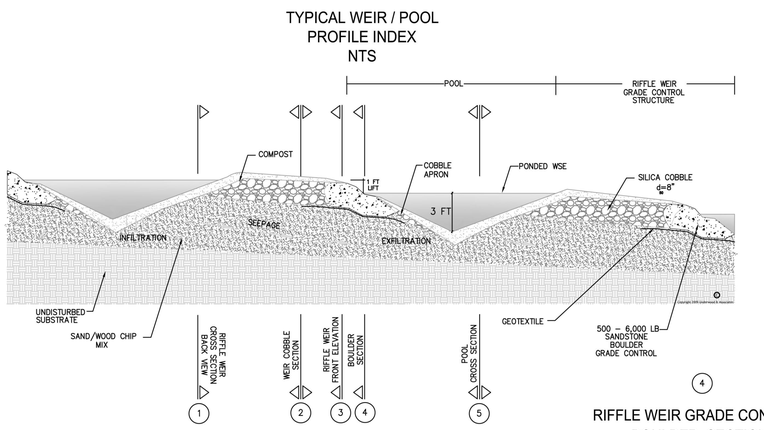

Figure 6. A profile of a typical RSC weir/pool design

Conclusion
Milkhouse Run has been impacted by over a half century of development without any significant stormwater control. Retrofitting this area with stormwater facilities will be costly and time consuming. Despite the fact that this watershed is lightly developed relative to the rest of the District, Milkhouse Run showed severe downcutting and in-stream habitat degradation.

Installing the RSC on Milkhouse Run has stabilized the stream and restored habitat while providing the District time to work upstream to retrofit the watershed with LID practices. Unlike retrofitting the watershed with LID, which will take many years, the Milkhouse RSC took two years to design, permit and install.

The Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) have raised concerns about the use of RSCs, contending that RSCs are essentially equivalent to filling in stream channels. Both agencies have expressed a preference for natural stream channel design (NCSD) techniques. Yet this project could not have been constructed using NSCD as envisioned by the EPA and USACE; the NPS would not allow the removal of trees and the land disturbance that would have been required.

EPA and USACE have also expressed that rather than installing a RSC, the contributing watershed should be retrofitted with LID or other stormwater controls. They have stated that stormwater treatment should not take place in the stream, but rather upstream.

DDOE believes that RSCs are consistent with NSCD because the Priority 1 approach of NSCD is to reconnect the stream to its floodplain[2]. We also believe that waiting for retrofits will lead to further stream degradation and habitat loss. In an urbanized area, one must to accept the reality that our tributaries are highly impacted by stormwater volumes. Although it is a goal to return these streams to pre-development hydrology, this is not realistic in the short term. RSCs are an attempt to restore streams with the recognition of the reality of high stormwater volumes and peak flows.

Figure 7. Completed RSC at Milkhouse Run

Figure 8. Erosion along Soapstone Run, a future RSC project

Figure 3. A panoramic of the two restored tributaries taken from their confluence