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Urban Streams

A solar powered filatration system installed for research on Beargrass Creek in Louisville, Kentucky.

The Beauty of Stream Restoration and Pet Waste Reduction Programs

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In the Chesapeake Bay, stream restoration is being hotly debated. The outcome of this debate could have some big implications for how widely stream restoration is used by communities to clean up local streams, rivers, lakes, and other water bodies. There are several critical issues in this debate, but at the heart of it, the question is just how beneficial is stream restoration, especially since the costs to implement this practice can be tremendous.

For a time, the stormwater world seemed unilaterally focused on rain gardens and bioretention, so the debate is a welcome one.[1] The reality is that rain gardens alone won't get our nation's water clean enough to swim, fish, and drink from, even if money was no object. Rain gardens will certainly always be part of the picture, but that's just it. There is a big, broad landscape of practices to choose from, and sometimes the hardest job is figuring out the right mix for each and every community, and oh yeah– figuring out who does what and how.

A friend has told me on several occasions, "It's hard to know what you don't know." A big part of the problem of not knowing the full benefits of stream restoration is that a case needs to be made for why some of these tools are not as well touted under the umbrella of green infrastructure.

Enter stream restoration, illicit discharge elimination, gross solids abatement, and pet waste reduction. All very different practices, but potential pieces of the puzzle.

Stream restoration is probably the most well-known for its benefits. In fact, Issue 24 of Sustain, Spring/Summer 2011, was dedicated to stream restoration. The articles in that issue addressed a wide range of trials, tribulations, benefits, and successes of stream restoration projects around the country.[2]

Stony Run, a section of stream in the Roland Park region of Baltimore City, should be added to that list of inspirational and beautiful stream restoration projects. (This may be biased since I grew up in Baltimore.) This controversial project was led by then Baltimore City's Chief of Surface Water Management Division, Bill Stack (in full disclosure, Bill now works for the Center for Watershed Protection), and the stream heralded some of the worst features—steep eroding banks, exposed sanitary lines, and sediment and nutrients ending up in the Inner Harbor and, ultimately, the Chesapeake Bay. This project went beyond your typical stream restoration by repairing sanitary infrastructure to reduce sewer leaks and wet weather overflows.

Despite initial opposition from some community members, they eventually came around, and the end result is a stream with stabilized banks, a functional stream corridor, reduced pollutants and bacteria from sewage, and even the addition of blacknose dace, a species of fish usually found in only the most pristine streams.

Bill's response to critics that argued for a focus on watershed practices like rain gardens and bioretention instead of restoration was, "You have to put out the fire first, and this project will stop the massive loads of sediment and nutrients from eroding stream banks," (personal communication, September 29, 2014). Implementing enough watershed controls to stop the erosive stream flows could take generations and have an unaffordable

price tag. The Stony Run was dumping an estimated 1,805 tons of sediment and 2,500 pounds of nitrogen every year. By improving 5,000 linear feet projected at a cost of $5.4 million ($363,000 annually, amortized over 20 years at 3% interest), this project reduced the sediment washing down stream by approximately 45 dump trucks a year. (Yes, the big ones that can carry 25 tons). This project used Protocol 1 of the Chesapeake Bay Program expert panel report "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" finalized in 2014.[3]

In comparison, reducing that much sediment and nitrogen using rain gardens would take roughly 3,500 acres and 350 acres, respectively (treating one inch of runoff at 30% impervious), with a cost of $8 million and $813,000 per year, respectively (assuming EPA Chesapeake Bay Program retrofit reduction efficiencies of 75% annual sediment reduction and 60% annual nitrogen reduction for Baltimore City, MD).

Of course, a project of this magnitude requires making a case beyond cost per pound of pollutants removed. Choices have to be made about the type of specific in-stream and riparian practices, project location and feasibility, and funding. But for the folks who care about water quality, the cost per pounds removed is one of the leading drivers for determining feasibility of a project.

Hopefully, the debate occurring in the Chesapeake Bay will answer questions such as "Just how many pounds of pollution can be claimed with each stream restoration project?" and "How much sediment originates from the stream channel versus the watershed?" Although the EPA Chesapeake Bay Program has already substantially changed protocols for estimating sediment and nutrient load reductions for stream restoration, more data is needed to improve the accuracy of techniques and to help communities choose the most effective methods for implementing these practices. The implications of this debate and the implementation of subsequent projects could be tremendous, potentially spawning a new suite of stream restoration projects in the Chesapeake Bay and, hopefully, setting the precedence for change in Kentucky and other areas of the country.

Bill Stack is quick to point out that community residents in the Stony Run area had other concerns. Issues like the disruption from construction equipment during barbeque season and cutting down trees were raised. Bill notes, "I got challenged a lot about the project, questions about its value and the expenses. I had one answer to that—the Clean Water Act" (personal communication, September 24, 2014).

Bill, of course, is talking about the fact that Baltimore is mandated to take certain measures to clean up its water and substantially reduce its pollutant loads. Under the Clean Water Act, Baltimore City, like many urban areas, must meet specific standards for pollutant load reduction. In addition, the City is under a consent decree requiring a comprehensive wastewater collection system evaluation and rehabilitation program, which is why the stream restoration project was combined with a

Dry weather discharge in the Stony Run.

sewer rehabilitation project. The program specifically requires "addressing sources of sewage located in the storm system," which is ironic given that the stormwater and sewer system were designed to be separate systems unlike other communities where stormwater and sewage are in combined systems.[4]

Kentucky is no stranger to these clean water requirements. Approximately 100 communities in Kentucky are bound by federal and state regulations under the Clean Water Act to take specific actions that will make these waters swimmable, fishable, and/or drinkable.[5] Rain gardens and stream restoration should be part of the solution, but so should illicit discharge elimination (such as sewage), gross solids abatement, and pet waste reduction.

Some may argue the beauty of stream restoration is a lot easier to sell than the other relatively unknown practices that are critical to attaining swimming, fishing, and drinking water goals. While this is true to an extent, for those of you who care about clean water there should be some concern about the absence of these powerful practices in the stormwater lexicon.

Starting with dry weather discharges, which can have a much greater impact to receiving waters than wet weather overflows of separate and combined sewer systems. Although these are one type of discharge, they include all discharges from pipes that are not permitted. Field studies have found that these illicit discharges, especially in dry weather, can be persistent in many older urban areas.[6, 7, 8, 9, 10, 11, 12] Alarmingly, these pipes, whether intentionally or unintentionally plumbed to the stream, are steadily spewing raw sewage and other pollutants. Both the detection and fixing can be elusive, since tracking requires

Fish sampling in the Stony Run.

field work. The detection requires a combination of looking for the signs of illicit discharges by smell and sight, and verifying through collection and quick analysis, both in the field and lab. Research has shown that pipes that leak during dry weather can be a substantial component of pollution loads to local streams.[6, 7, 8, 9, 10, 11, 12] For example, a study of the Inner Harbor in Baltimore City found that eliminating these dry weather flows could make the Inner Harbor suitable for human contact recreation at least for part of the year.[11]

Aside from the obvious problem of raw sewage, the hindrances to implementing effective illicit discharge programs are many. To start, the regulations and guidance need updating. At the time the regulations were written, they were very focused on industrial wastes, missing the dry weather sewage and misconnections that have been found in the field. More specifically, the program doesn't address pipe sizes less than 36".[13] Field studies have shown that many of the pipes that are flowing illicit discharges are less than 36".[14] Furthermore, basic testing for bacteria and other indicators of sewage are not currently required in the regulations. The guidance on detection itself sorely needs updating as new information has been found during the 30+ years since the original regulations were published.

As a result, the subsequent consent decrees issued to various jurisdictions also lack this specificity. For example, in Louisville and Jefferson County, the consent decree for the Metropolitan Sewer District mandates that overflows can only exist in combined sewer communities during wet weather. However, the amended document doesn't address directly the issues of dry flows from separated storm sewer systems.[15] Separated systems constitute about 77% of the systems for these jurisdictions.

These regulatory issues combined with the complexities of whether illicit discharges should be managed by stormwater or sewer districts further complicate the matter. Some of the questions the issues raise include: Are the illicit discharges a sewer problem or a stormwater problem? Who should fix them? Who has the resources to fix them? How big of a problem is it relative to other larger sewer problems? How does one detect them? And, finally, are there potential incentives or disincentives to detect them?

The complexity doesn't end with the regulations. Field studies have shown that many communities have not updated or mapped their sewer systems, making implementation of any program difficult. Lack of this critical data is prohibitive to actually figuring out both how to detect the issues and fix the problems.

There are other questions and issues that are also related and aren't necessarily incentives for communities to do something about this issue. For example, if the elimination of sewage discharges is mandated, should the associated reductions in nitrogen, phosphorus, or bacteria reduction be credited towards meeting local TMDLs since communities should be fixing these discharges anyway?

Not allowing communities to get pollutant removal credits for something that is known as a potentially rampant problem seems short-sighted, especially since the magnitude of the problem has been unknown up to this point. By providing incentives to fix the problem, which has a low cost per pound of pollution reduced, communities can substantially eliminate a big source of pollution.

For some communities, other not-so-obvious choices in practices exist. Gross solids (large debris such as leaf litter and trash) abatement, which can be addressed through composting/collection programs and street sweeping, is another practice that can significantly reduce pollution loads. Studies show that when you look at what's on the streets, it's organic matter like leaf litter and grass clippings that can be the most significant sources of nutrient pollution.[16] That's not to say we should cut down our trees, as some may deduce from those findings. The data on the benefits of trees has long been documented and a fight to cut trees would be a difficult uphill battle with few proponents. However, urban environments do not have the benefit of the forest floor to recycle nutrients from leaf matter. Instead, leaves and other organic debris are effectively transported to the nearest stream via the gutter and storm drain system. So while trees and other vegetation are beneficial, in urban environments leaves and other organic solids need to be managed through a collection or street sweeping program.

As an example, the Eastern Shore of Maryland is using some unique nets, attached to culverts to capture their gross solids. The devices traps leaves and other debris from flowing downstream. Though the material itself has a relatively low concentration of nitrogen and phosphorus, the sheer mass of material, nitrogen, and phosphorus reductions add up.

And last, but certainly not least on the radar, should be pet waste programs. Although it's illegal to not pick up after your

Table 1: Comparison of Cost per Pound Remove for IDDE/ Pet Waste/ Gross Solids/ Bioretention/Stream Restoration

Cost-Effectiveness of Urban Stormwater BMPs*[12]			
	Cost Effectiveness ($/lb)		
BMP	TN	TP	TSS
Bioretention (new - suburban), A/B soils, no underdrain	339.00	2,934.83	5.82
Bioretention (new - suburban), A/B soils, underdrain	387.43	3,326.14	6.55
Bioretention (new - suburban), C/D soils, underdrain	1,084.81	5,543.56	9.53
Bioretention (retrofit, highly urban C soils)	2,078.97	12,500.51	22.25
Bioswale (new)	309.13	2,653.91	5.23
Dry Detention Ponds (new)	4,597.20	21,143.16	44.43
Dry Extended Detention Ponds (new)	1,149.30	10,571.58	7.41
Filtering Practices (sand, above ground)	979.43	4,541.97	6.47
Filtering Practices (sand, below ground)	1,065.38	4,940.56	7.04
Forest Buffers	150.86	1,851.00	7.66
Hydrodynamic Structures (new)	7,146.10	32,865.88	69.06
Illicit discharges- correction of cross-connections	17.70	70.79	6.69
Illicit discharges- sewer repair	8.86	35.43	0.89
Impervious Urban Surface Reduction	2,439.05	7,354.09	11.96
Infiltration Practices w/ Sand, Veg. (new)	488.64	3,398.98	5.78
Infiltration Practices w/o Sand, Veg. (new)	496.65	3,251.47	5.53
Permeable Pavement w/ Sand, Veg. (new), A/B soils, no underdrain	2,528.09	17,585.50	31.45
Permeable Pavement w/ Sand, Veg. (new), A/B soils, underdrain	4,044.94	28,136.81	38.19
Permeable Pavement w/ Sand, Veg. (new), C/D soils, underdrain	10,112.36	70,342.02	48.61
Permeable Pavement w/o Sand, Veg. (new), A/B soils no underdrain	1,926.47	12,563.10	22.47
Permeable Pavement w/o Sand, Veg. (new), A/B soils, underdrain	3,210.79	20,100.97	27.28
Permeable Pavement w/o Sand, Veg. (new), C/D soils underdrain	14,448.56	50,242.42	34.72
Pet waste program	0.44	3.36	N/A
Retrofit of Existing Dry Pond (conversion to wet pond or wetland)	565.52	2,311.92	3.64
Street Sweeping – Mass Loading Method	1,389.99	3,474.98	11.58
Street Sweeping – Street Lane Method	2,259.29	15,715.71	9.95
Tree Planting	657.58	9,621.48	46.23
Urban Growth Reduction	246.60	1,383.85	2.64
Urban nutrient management (recommended efficiencies)	476.59	2,378.97	N/A
Urban Stream Restoration (original efficiencies)	2,613.21	17,421.41	26.13
Urban Stream Restoration (recommended interim efficiencies)	261.32	768.59	0.96
Vegetated Open Channels, A/B soils, no underdrain	289.61	2,663.93	3.60
Vegetated Open Channels, C/D soils, no underdrain	1,303.25	11,987.68	5.04
Wet Ponds and Wetlands (new)	696.63	2,847.91	4.49
Wetlands (retrofit)	1,160.28	6,670.36	10.99

* Cost-effectiveness values were used to group each BMP into categories of High, Moderate and Low cost-effectiveness for each of the three pollutants, as depicted by the green (High), yellow (Moderate), and orange (Low) shading in Table 2. Cutoff values between groups were based on natural breaks in the data.

dog and the subject of fecal matter can be both comical and gross, the fact is that dog feces is a large component of bacteria and nutrient problems in many streams. So while dog "poop" isn't so beautiful, a combination of public education, signs, "poop" stations, and enforcement can significantly curb this problem, making the solution a beautiful option in the mix of practices.

The evidence for illicit discharges, gross solids, and pet waste clean-up isn't just qualitative. The cost/ benefit analysis of these practices are staggering, despite their "not appropriate for dinner table talk" qualities.

Part of the problem may be that communities have no idea how to select the best combination of tools to use. For those wanting to evaluate a broader suite of practices and prioritize them based on cost-effectiveness, tools like the Clean Water Optimization Tool can be one place to start. This simple tool allows users to develop restoration scenarios that optimize Better Management Practice (BMP) selection based on cost-effectiveness for a particular pollutant (Total Nitrogen, Total Phosphorus or Total Suspended Solids). It also incorporates assumptions about feasibility so that the resulting scenarios are actually achievable rather than just a rubber-stamp exercise. The tool churns out a priority list of practices and the number of units that must be treated as well as the cost and pollutant reduction associated with each BMP. Included in the tool is a mixture of stormwater retrofits, land use change practices, and municipal programs and practices that are not traditionally thought of in the mix.

So if you've made it this far in the article, you're asking, "Why aren't we using them to meet pollution reduction in every community?" For one reason or another, the stormwater crowd seems to have been distracted from the discussion of a broader set of solutions for too long.

Rain gardens definitely have their place. Green roofs and bioretention can also be powerful tools in the mix, but it's time to let the practice catch up with the research and open up the discussion of actually meeting the goals set by the Clean Water Act with a broader array of tools and practices. Let's put it all on the table—stream restoration, illicit discharge detection and elimination, gross solids elimination, and pet waste removal. These practices and others should all be considered throughout Kentucky and across the country.

There are likely many more options that are lacking in research or have not received the attention that they deserve. With the debate happening in the Chesapeake Bay, and the impending changes in regulations for some of the practices occurring at EPA's Chesapeake Bay Program, the first train has left the station. The question now is who, how, and when will communities respond when the train finally arrives at their station? Emptying and organizing the toolbox may be a good way to make sure we know we actually have what can save us time and money, and get us a lot closer to attaining clean water for swimming, fishing, and drinking.

As the Executive Director of the Center for Watershed Protection, Hye Yeong's responsibilities include organizational management, fund-raising, and program development. With nearly 20 years of experience in nonprofit management and a background in biology, Hye Yeong has combined her education and training to help lead the Center toward a multi-disciplinary strategy to protect and restore watersheds throughout the country. Her project experience has included a wide range of subjects, including environmentally sensitive site design, watershed planning, and consensus building. Hye Yeong has a B.S. in Biology, an M.S. in Management, and an MBA. Hye Yeong lives in Ellicott City with partner Craig and their kids Cassie, Isa, and Rye, enjoying fishing, football, traveling, scuba diving, camping, eating good food, and good company when she can.

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