



Let's start at the beginning...



We live in cities. Cities generally have a lot of pavement.

When it rains, water hits pavement and picks up debris, oil, dirt and other pollutants that are all over our streets and parking lots. Think about what's on the streets. Animal waste. Gas and oil that leaks from cars. The salt we use to melt snow. A bajillion cigarette butts. Now this soiled water goes through storm drains, which drain directly into streams and creeks, without being cleaned. Gross, right? But wait. It gets worse.

In some cities (approximately 772 of them), our sewers have what is called a 'combined sewer' system, which means simply that pipes that carry sewage (waste we produce in our homes, offices, etc, like poop) are combined with those that carry dirty stormwater. During very heavy storms, stormwater floods the combined sewer system and so as not to overwhelm the wastewater treatment plant, all the mixed sewage water (filled with feces) and the stormwater (filled with garbage) flows directly into creeks and streams.

They say that the solution to pollution is dilution. But sometimes there's more poop than there is water in our creeks and streams, resulting in what some call "poonami."

Okay, so that's disgusting. What the heck does that have to do with green infrastructure?

All of these problems with sewage and pollution in our creeks and streams are basically about a volume of water moving on our streets, which are impermeable. Green infrastructure is a strategy to reduce that volume of water and slow it down. This can happen many ways, but one of the cheapest, easiest ways of slowing down water is to make surfaces more permeable.

Think about how water moves on an impermeable surface, like a driveway. It moves pretty fast. It finds cracks and fills them. Now think about how it moves on a permeable surface, like dirt. It kind of moves around in a circle and then goes into the soil. Dirt, unlike concrete, allows water to slowly percolate. This reduces this race of stormwater flooding during heavy storms.

Dirt does something else pretty important. Dirt catches pollutants, acting as a natural sieve to protect creeks and streams from pollutants.

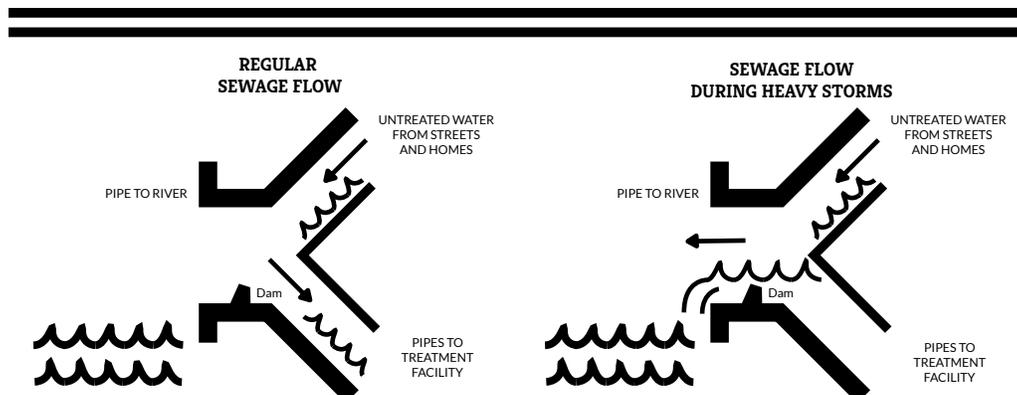
This sounds like a big problem. What can I do about it?

Luckily, any neighborhood can do a lot to protect rivers, streams and drinking water sources. Here are 5 simple projects for any neighborhood in the U.S. to address issues of storm water.

What's a CSO?

Combined Sewer Overflow (CSO) is the discharge of storm water and wastewater (potentially untreated human and industrial waste, toxic materials, and debris) into a water body. Noxious CSOs are a major water pollution problem for cities that use a single sewer system and for cities with separate systems that overflow during heavy storms and floods.

Since the 1990s, the EPA and municipal officials have been working to address pollution from sewer overflows so that cities can comply with the **Clean Water Act**. These efforts often include expensive infrastructure construction projects. Luckily, communities can use green infrastructure to help reduce storm water in CSOs.



HOW TO START A RAIN GARDEN

by Robyn Mace



1. Pick a Site for your Rain Garden.

Observe how the water flows over the ground. If you have them, consult aerial photos and topographic maps. To maximize the storm water runoff you'll catch in your rain garden, avoid wet spots, septic systems, highly shaded areas, bedrock, steep slopes (>12%), and underground utilities (**Call 811 before you dig!**). Stay at least 10 feet away from the foundations of buildings. Plan for overflows.

2. Test the Soil.

To determine the depth of garden, you'll want to test how quickly the water is absorbed. Dig a one-foot deep hole. Fill it with water and watch it drain. When the first test's water is absorbed, fill it again. If the water does not drain within 24-36 hours, you may have to make the rain garden deeper or add gravel or rocks to the soil. Use the soil texture triangle to help decide what you might add to the soil to help the ground absorb water faster.

3. Prep the Site.

Mark the site you want to transform. Generally, you'll want the rain garden to be twice as long as it is wide. Excavate the area as deep as you need. Set the dirt aside for later. Order plants. You may want an outlet pipe on large gardens, on the lower side. Mix the combination of gravel and rocks with soil and loosely fill to half. Save remaining soil mix for planting. If your site is very large, or very deep, you may want to hire a mechanical digger to prep the site before the build day.

4. Build your garden!

Make it a day! Use native species to enhance local biodiversity. Host a workshop in the morning on rain gardens, water quality, storm water management and green infrastructure. In the afternoon, eat lunch, plant your garden and mulch. Mark plants with tags or flags and take a picture for future maintenance and planning. You will need volunteers and tools (gloves, shovels, rakes, wheelbarrel(s) to move soil and mulch).

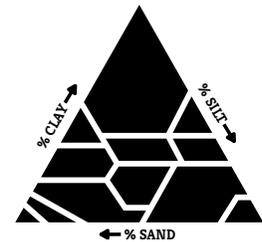
5. Maintain & Enjoy!

Green Infrastructure grows stronger over time. But the first year will require the most attention, so plan to maintain it in spring, summer and fall. Be sure to visit the site during and after heavy rains. Watch for and prevent soil erosion. Weed, replace plants, remove sediment, and mow the perimeter as needed. Remove trash daily or weekly. Refresh mulch 2-3 inches after first frost. Prune annually. Renew or replace mulch every three years. Make a big beautiful sign that invites your neighbors to learn and participate. Don't forget to explain how your garden is connected to your watershed.

There are lots of great resources and information on rain gardens, bioinfiltration, low impact development and green infrastructure. To get started, check with your local Agricultural Extension, storm water or water quality management agency or department, or the [Great Lakes Watershed website, here.](http://www.greatlakeswatershed.org/rain-gardens.html)

Unfamiliar with Soil Texture Triangles? There's an interactive way to learn about them at

<http://www.isa-arbor.com/education/onlineresources/CDDemos/triangle.swf>



Supplies & Estimated Costs (based on a 8 foot x 15 foot garden):

- Plants - \$500
- Downspout
- Soil - \$250
- Lunch for Volunteers - \$100
- Welcome and Educational Signs - \$150
- Mechanical Digger Rental - \$300

Estimated Time: 40-80 hours (to plan, prep site and execute.)

Best Season: Fall

Number of friends needed: Invite 1-2 neighbors or friends to help plan and then bring a team of up to 10 for the build day.

Robyn Mace, Memphis, Tennessee, is a strategist, planner and researcher who likes being outside more often than she is. Passionate about problem solving and public policy, she finds green infrastructure, low impact development and rain gardens particularly compelling, as they are beautiful and functional!

HOW TO BUILD A RAIN BARREL CATCHMENT SYSTEM

by Devona Sharpe



- 1. Assess your roof structure.** Make sure there is a gutter on the roof to allow water to drain into a channel. You don't want the rain barrel too far from the garden, but you may not want it closer than three feet from a building.
- 2. Decide on a barrel size.** A good rule of thumb is to measure the surface area of the roof water (in feet) and multiply that times the number of inches of rainfall your area gets (per month) and then multiply that times .623. This will equal the average gallons your barrel will collect per month.

$$\begin{array}{r} \text{Roof's Surface Area (in feet)} \\ \times \text{Inches of rainfall (per month)} \\ \hline \text{x .623} \\ \hline \text{Average gallons captured per month} \end{array}$$

Pickle barrels are a great size for community gardens. They hold about 50 gallons of water and they're really cheap!

- 3. Gather your supplies.** You'll need access to the gutter on the adjacent building, a downspout (available at most hardware stores), PVC pipe, joints and meshing. Rain barrels are available in many areas for free. In NYC, the Department of Environmental Protection gives away pickle barrels for free or very cheap most springs.
- 4. Assemble the rain barrel.** You can watch a video of Devona explaining how this is done on ioby.org/resources. Another great resource is from GrowNYC at grownyc.org/openspace/rainwater
- 5. Test your water.** You're not going to drink the water, but you want to make sure it's good so you can eat the veggies you're growing with them. Get a kit from DEP (nyc.gov/dep) for free!

Supply List & Estimated Costs:

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-
- | | |
|-------------------------|------------------|
| · Pickle Barrel - \$100 | · Joints - \$15 |
| · Downspout - \$25 | · Meshing - \$15 |
| · PVC Pipe - \$25 | |

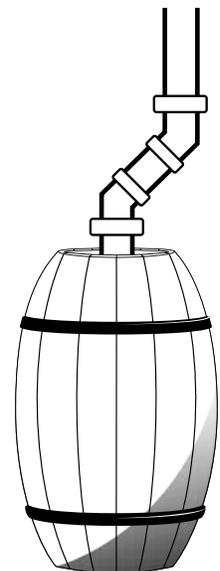
Estimated Time: 3 hours

Best Season: Early Spring

Number of friends needed: Number of friends needed: 1-2 friends be helpful for creating the vision and for helping out during the assembly.



Devona Sharpe, Brooklyn, NY, is a community gardener, rainwater capture specialist and waterfront conservation professional. She has worked with the Rockaway Waterfront Alliance and the Bronx River Alliance in New York City.



HOW TO DEPAVE ANYTHING

by Eric Rosewell



1. Create a vision.

Take a look at the site that you want to depave. How does water interact with it? How does it drain? Consider ways that you can disconnect spouts and pipes from the sewer system and instead use the newly depaved area for on site filtration with a bioswale or a rain garden. If this is your first time depaving, start small, with 500 square feet or less. Make sure you have a plan, drawn to scale, and find out from your city if you need a permit to get started.

2. Remove the impervious surface!

If you have asphalt, rent a walk-behind diamond-blade saw from a construction equipment supplier. A diamond-blade saw will help you prepare the surface so that you (and a bunch of friends!) can easily pry it up with a pry bars. You might want to have a sledgehammer around in case you need to break up really stubborn pieces.

Asphalt is crumbly and not suitable for reuse. Luckily, it can be recycled in most cities. Contact a local waste hauler to inquire about disposal and have them deliver a drop box to load the asphalt chunks into.

If you have concrete, you're gonna need a jackhammer. This can also be rented from an equipment supplier. Use the point bit to make small cracks. Then "explore" the cracks with the chisel bit to break it into movable pieces. This method will make it easier for you to keep the jackhammer from falling over on your while you're working.

Concrete is hard and can be reused to construct walkways, fire pits, or garden beds. If you don't want it, Craigslist it.

3. Remove gravel and dirt.

Big blocks of asphalt and concrete are heavy. You'll need two people to pry up and remove each piece. Have a wheelbarrow or hand truck handy to load and remove pieces. Below the surface you'll likely find 3-6 inches of gravel. You can shovel this out of the way and reuse it for a walkway or to create a drainage system. The lifeless soil beneath the gravel is compacted and will need to be broken up with a pickaxe in order to mix in fresh soil.

4. Add fresh soil and plants.

Make your new greenspace beautiful and ready to help catch stormwater. Till a 3-way soil mix into the native soil you've broken up. Use plants that are native to your region to create urban habitat and reduce the need for watering and fertilizer. Consider testing the soil for pollutants like lead before planting vegetables. Take photos of your process to show off the transformation!

Paved surfaces contribute to storm water pollution, whereby rainwater carries toxic urban pollutants to local streams and rivers, greatly degrading water quality and riparian habitats. Pavement also stands in the way of planting rain gardens and bioswales.

This is a big job and before you undertake such a project it is best you know what you are getting yourself into. Before you begin, there are many aspects that need to be considered. This guide is meant to be a short outline for getting started, but there are many more resources available for you on depave.org/learn/how-to-depave. Depave, a nonprofit based in Portland, Oregon, promotes the removal of unnecessary pavement from urban areas to create community green spaces and mitigate stormwater runoff, and reconnect urban landscapes to nature.



Eric Rosewell, Portland, Oregon, is a designer, greenspace geek, and master landscape recycler. He directs **Depave** in putting empty spaces to good use and bringing them back to life.

Supply List and Estimated Costs

- Diamond-blade saw or jackhammer - \$125
- Drop box (asphalt, debris, extra gravel) - \$200
- Pry bar - \$25
- Pickaxe - \$20
- Sledgehammer - \$20
- Wheelbarrows or hand trucks - \$50 - \$200
- Soil/compost - \$30/yard
- Plants - tbd
- Friends and volunteers (and snacks and drinks for them!)

Estimated Time: 4-8 days, for planning and implementation

Best Season: Spring, Summer, or Fall

Number of friends needed: 2-10 depending on the size of your project

HOW TO BUILD A BIOSWALE

by Irene Nielson



1. Pick a location. Find a low-lying area, ideally where water already collects. Be careful that the area doesn't have a steep gradient. Anything greater than 5% is not practical. Use the following rule of thumb: the total surface area of the swale should be one percent of the area that drains to the swale. (Remember an acre is 500 square feet.)

Unless there is a bypass, the swale must be big enough to pass storm water during peak flooding. The storm water should never submerge the height of the grass.

More details on site design at

http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_vegswale.pdf

2. Select drainage material. Coarse sands and gravel are highly permeable, so water can pool in the low-lying area and drip into the soil below.

3. Make it fabulous! Drains can be naturally curvy, which could create a delightful aesthetic in your space. Select some drought and flood resistant plants native to your region. The greater the surface area of the vegetation, the more efficient the swale, so consider using plants with lots of surface area, like a fine, close-growing, water-resistant grass. What are your pollution control goals? Specific plants are more effective than others to remove certain pollutants. Plants that will thrive in swales include reed canary grass, grass-legume mixtures and red fescue.

A pretty good search engine for native plants by state:

<http://www.wildflower.org/plants/>

Follow this guide for more info on pollutant removal:

http://www.nyc.gov/html/dep/pdf/green_infrastructure/bioswalecare_handbook.pdf

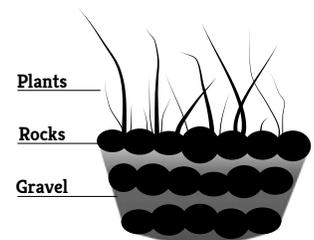
4. Maintain & Enjoy! Green Infrastructure grows stronger over time. But the first year will require the most attention, so plan to maintain it in spring, summer and fall. Be sure to visit the site during and after heavy rains. Watch for and prevent soil erosion. Water during droughts. Weed, reseed and replace plants, remove sediment, and mow perimeter as needed. Remove trash daily or weekly so your swale doesn't accidentally turn into a dam. Refresh mulch 2-3 inches after first frost. Prune annually. Renew or replace mulch every three years. Make a big beautiful sign that invites your neighbors to learn and participate. Don't forget to explain how your bioswale is connected to your watershed.

More information on caring for your bioswale can be found at

http://www.nyc.gov/html/dep/pdf/green_infrastructure/bioswalecare_handbook.pdf

A bioswale is a low-lying area designed to manage stormwater with natural vegetation. Bioswales can be used in many places. Large-scale bioswales can be put strategically between a permeable surface, like a parking lot, and a waterway, like a nearby stream, to help reduce the stormwater that would otherwise pick up pollutants from the parking lot and carry them into the stream. But bioswales can be effective in many other areas, such as gardens.

Did we mention that bioswales are beautiful? A key part of bioswales is that something, like a plant, tree, or coarse gravel, slows down the water. These can add beautiful designs to your garden, yard, or riverfront park.



Irene Nielson, Brooklyn, NY, is on the ioby Board of Directors, and is an environmental professional.

Supply List & Estimated Costs:

- Plants - \$450
- Shovel(s) - \$200
- Pickaxe - \$20
- Gravel - \$350
- Sledgehammer - \$20
- Wheelbarrow - \$50-200

Estimated Time: Depends on the scale of the project, 40-80 hours

Best Season: Early Spring

Number of friends needed: 1-2 would be helpful for creating the vision and keeping company.

TAKING CARE OF STREET TREES

by Philip Silva



1. Phone a Friend. Taking care of street trees is a lot more fun with friends and neighbors. Turn it into a party. Send out invitations or use social media to round everyone up. Buy some snacks. Plug in a radio and play some tunes on a nearby stoop. Even a small group of two or three volunteers will attract attention from people passing by and help you recruit for your next tree care day.

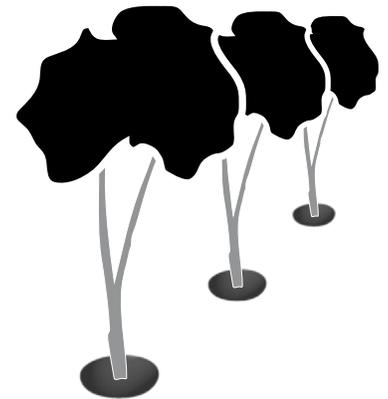
2. Make Some Space in Your (Tree) Bed. In many cities, street trees are planted in curbside soil beds that are just too small to accommodate big roots and fat trunks. The smaller the bed, the less rainwater a tree can soak up. The trick is to make that bed as long and wide as possible. First, remove any paving stones or cobbles you find in the tree bed. You may need a crowbar or a shovel to pry out stones that have been there for a long time. Just removing these pavers can make a big difference. If the bed is still too small, call your local Department of Public Works. Ask them to enlarge a tree bed by removing some of the nearby sidewalk or volunteer to do it yourself with written permission from the city. Remember, the more soil you can expose, the easier it is for a tree's roots to spread out and soak up rainwater without doing any damage to nearby pipes or pavement!

3. Loosen Up. Many street tree beds suffer from soil compaction—the inevitable result of thousands of people stepping on the soil and squashing it down so tightly that it can't soak up air and water. Your task is to loosen all that soil up. Use a garden cultivator or trowel to gently scrape at the soil. Be careful not to damage any exposed tree roots in the process. Though it may be tough going at first, if you keep scratching the surface week by week you'll eventually make a big difference.

4. Feed and Water. Adding mulch and compost to a tree bed turns it into a super sponge for storm water. Mulch helps the bed retain moisture (think of it as a blanket), and as compost and mulch break down over time, the nutrients become food for worms and other tiny creatures that burrow through the soil. Keep those critters well fed, and they'll do all the soil cultivating work for you. Trees also need water; especially young trees recently planted along the sidewalk's edge. Experts suggest that 20 to 30 gallons of water per week is best for young trees, particularly during long stretches without rain. Use a garden hose or a bucket with a small hole drilled at the base to slowly drip water into the bed. Trees would rather sip than slurp!

5. Shape it Up. Some cities have programs that train volunteers in the fine art of tree pruning. Cutting back dead or diseased branches can help a tree grow strong for decades to come. Search online for local tree pruning courses before attempting to do this on your own!

Street trees go a long way toward sopping up rainwater. Curbside trees with big canopies catch gallons and gallons of rainwater on their leaves, twigs, and branches, letting it slowly drip or evaporate into the sky long after the storm clouds have rolled away. And a street tree growing out of a large bed filled with fluffy loose soil can sponge up even more rain as it spills down the sidewalk during a downpour. The trick is to keep the street trees in your city healthy and growing strong.



Philip Silva, Brooklyn, NY, is a Ph.D. candidate in Natural Resources at Cornell University. He is also the co-founder and co-director of **TreeKIT**, an initiative that helps city dwellers measure, map, and collaboratively manage urban forests.

Supply List & Estimated Costs:

- Compost and mulch (\$10 for a large bag or free from your local Parks Department)
- Garden tools (\$15 for shovels and crowbars; \$5 for hand trowels and cultivators)
- Irrigation equipment (\$20 for hoses; \$5 for a 5-gallon bucket)

Estimated Time: 1-2 hours to begin, a few hours a month to maintain your tree bed love over the course of spring, summer and fall

Best Season: Spring, Summer, and Fall

Number of friends needed: 1-2 would be helpful for creating the vision and keeping company, but the more the merrier!

I'M READY TO START MAKING MY CITY MORE PERMEABLE! WHERE SHOULD I START?



In our backyards, of course!

Start on your block, in some public or pseudo public/private space that neighbors can convene. Maybe your own driveway. Maybe the sidewalk. Maybe the street tree in front of your house or apartment. Maybe a nearby intersection that you cross on a regular basis.

Of course, you should always start with places you spend time and where you can begin a conversation with the property owner, which, if you're working in a park, on a street or on a sidewalk, might be the city's department of parks or transportation.

If you're thinking big, remember our tips on community work.

Tips:

- 1. Be polite.** Most people don't think about storm water. And even fewer think about tearing up concrete as a way to be a better citizen. Be polite and friendly and recognize your role as an instigator.
- 2. Invite participation.** You're doing this because you care about your community. And you can only have community when you work with others.
- 3. Be positive.** You're trying to make your neighborhood stronger, safer and more sustainable for all. Focus on the benefits your project will bring.
- 4. Amplify your work.** Use socially connected networks like Facebook, Twitter, ioby, and blogs to make your project publicly known.
- 5. Future-tise.** Advertise the future you want by working with a friend or colleague who is a designer or architect to produce images of what the sidewalk, parking space, or driveway you're working on could look like with green infrastructure. This can help start a conversation and build a broader base of support beyond the normal naysaying neighbor or two.
- 6. Be professional.** A thoughtful and nicely designed temporary project may be permitted to stick around longer than slap down shoddy work. Conform to code wherever possible.

When you're making the case to a city agency, remember to lean on institutional resources like the U.S. EPA, NYC DEP, depave, ioby and others for support. The national organization Smart Growth America reminds us that "traffic-calming elements like chicanes, islands, and curb extensions – all popular in creating Complete Streets – provide site opportunities for bioswales, street trees, and rain gardens," and that "landscaping elements that help curb stormwater runoff – bioswales, planters, rain gardens, and street trees – are mutually beneficial for mobility and ecology."

Many guides, videos and resources to learn more about green infrastructure can be found at http://www.nyc.gov/html/dep/html/stormwater/using_green_infra_to_manage_stormwater.shtml