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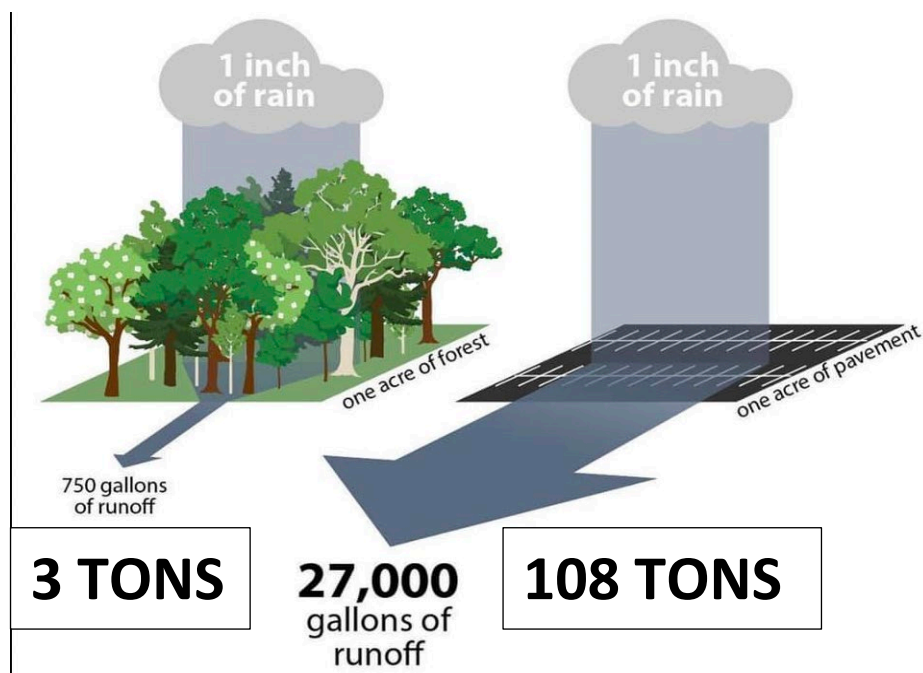


HABITAT RESTORATION ENVIRONMENTAL MANAGEMENT

STORM WATER MANAGEMENT GUIDELINES by Gordon Peabody, Safe Harbor 2023

www.SafeHarborEnv.com

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More than a few inches of rain/hr is considered *Storm Water*. Cape Cod's native vegetation, soils and sand, create a linked, natural system that performs during storms by directing surface water into our ground water table (percolation). Anytime we modify that simple linear process, by introducing impermeable materials, or by removing vegetation, we need appropriate mitigations to maintain performance standards for ground water recharge. Rainfall on impervious surfaces, initially spreads out in a thin sheet and is referred to as "sheet flow". Gravity directs sheet flow down slope. Where sheet flow, by design or default, begins "bunching up", a point source is created. *This publication identifies storm water challenges and sustainable mitigation choices.*

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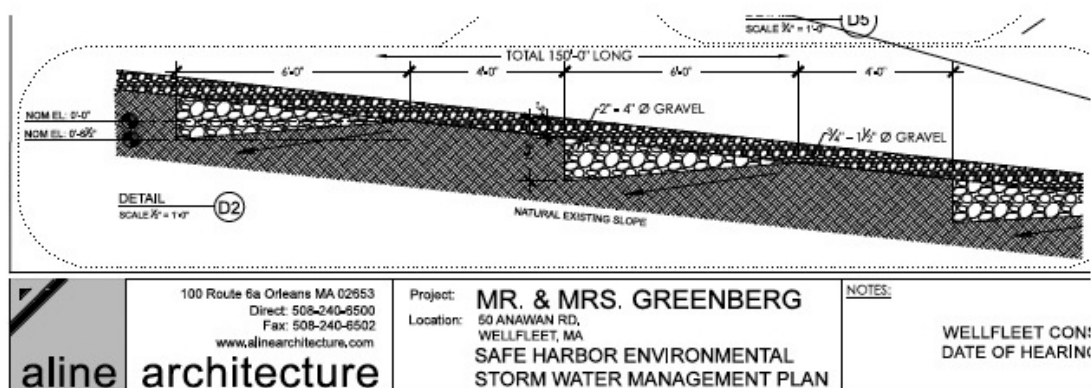
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ROADWAYS:

Impermeable, paved road surfaces provide clear models for demonstrating storm water characteristics on impermeable surfaces. As gravity directs sheet flow down slope, cumulative sheet flow accumulates as a point source and loses its innocence. Point sources have significant weight (mass) and speed (velocity), with the ability to scour and transport sediment.

“Step Swales”, an innovative, gravity driven, hybrid system, developed by Safe Harbor of Wellfleet and Aline Architecture of Orleans, utilizes “Smart Growth” strategies of managing storm water close to the source and combines traditional “Country Road” design strategies. Country roads use slightly raised crowns along the center, dividing and directing sheet flow to swales on each side. Continuous swales running parallel to roadways create unrealistic flow volumes. If swales are broken into sections, with their *upslope end lower* than their down slope end, the flow chain will be interrupted and percolation can occur effectively. Canting a roadway can also be helpful but crowning is more effective, because the flow is divided, then directed to mitigation. Step Swales are not intended to be comprehensive solutions to storm water impact but we believe they significantly contribute to reducing erosion risks by controlling up slope sheet flow.

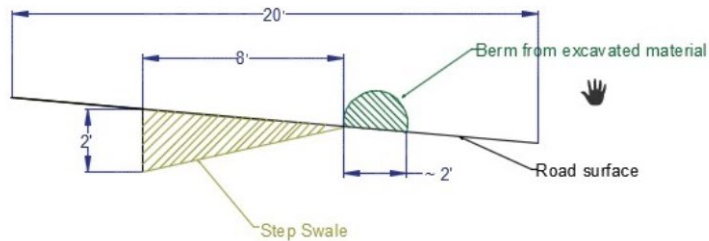
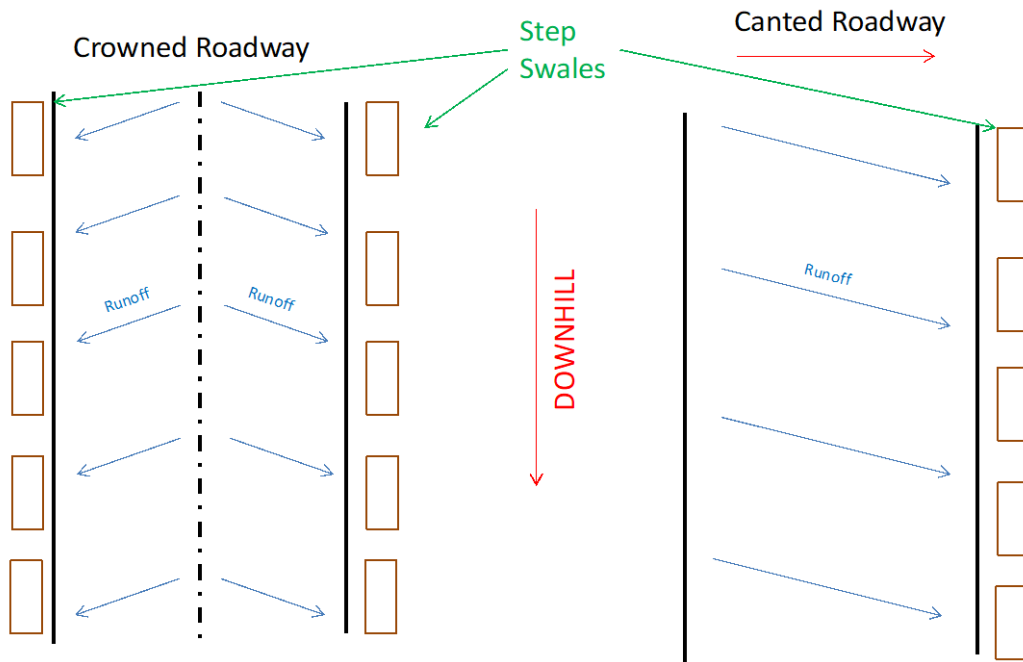
STEP SWALE HYBRID ROADWAY STORM WATER SYSTEM



Above Image Courtesy of Aline Architecture, Orleans, MA.

Controlling up slope sheet flow sources is at the core of reducing down slope risk.

Step Swales- Plan View



BERMED STEP SWALE -- PROFILE VIEW

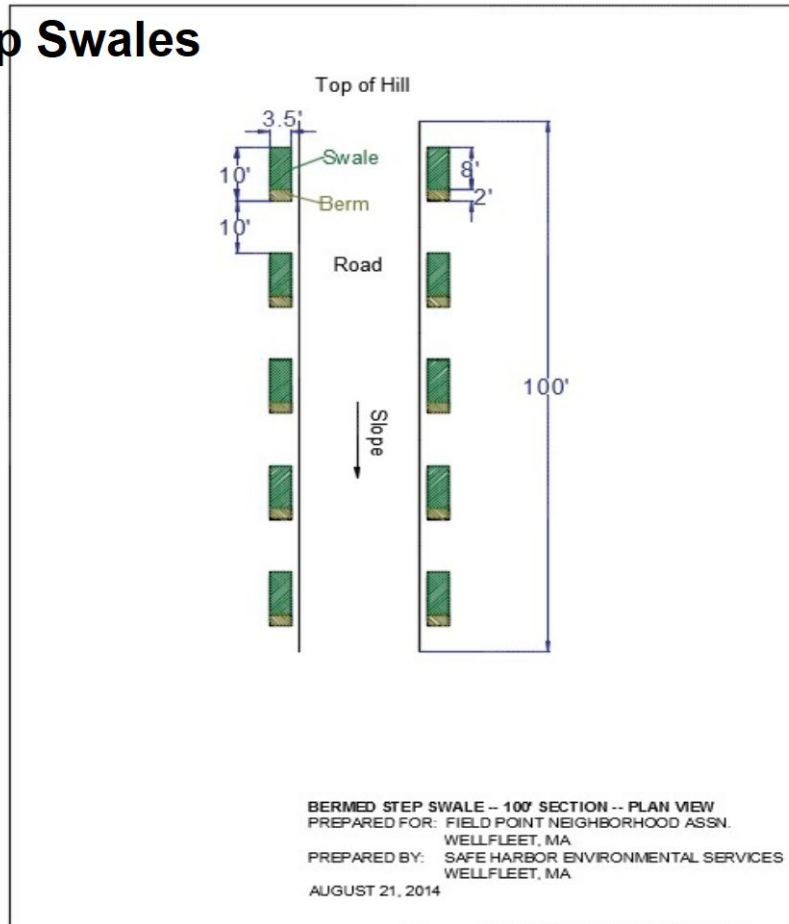
PREPARED FOR: FIELD POINT NEIGHBORHOOD ASSN.
WELLFLEET, MA

PREPARED BY: SAFE HARBOR ENVIRONMENTAL SERVICES
WELLFLEET, MA

AUGUST 21, 2014

“Bermed Step Swales”, are an intuitive design strategy which serve two purposes. Utilizing some of the material excavated to create the swale and enhancing swale capacity by creating a downslope berm. In canted roadways, they would play a significant role in increasing percolation performance. The dimensions we have used can be revised for other roadways. The advantage of step swales and bermed step swales is that they are low profile, low maintenance, gravity driven and sustainable. We often use geotextile filter fabric to line the swales and fill them with 2” gravel.

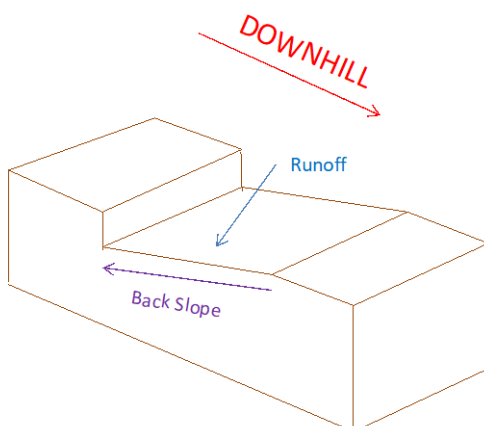
Step Swales



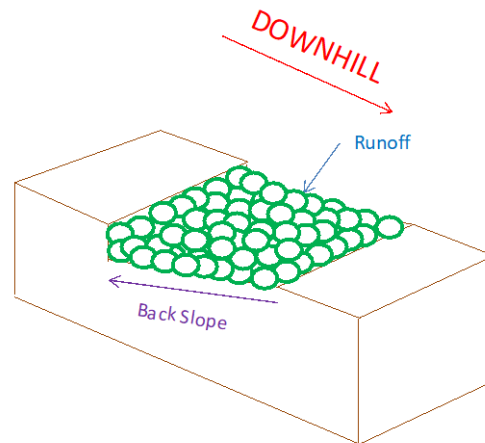
Step Swales- Profile View

Images pgs 2-4 by Safe Harbor
 Environmental Engineering
 Intern Tony Leonard, 2014

Basic Step Swale



Gravel-filled Step Swale



IMPROPER STORM WATER MANAGEMENT: REPEATING FAILURES IN WELLFLEET

“Smart Growth” storm water management strategies recommend managing percolation systems upslope, close to sources. Here are results of a down slope management system.



Wellfleet

4.97"



DISCUSSION: Impervious, paved surfaces create excess sheetflow. If upslope areas are not broken up by percolation systems or canted to control point sources, impressive water weight from multi inch storm water event overwhelms and eventually collapses the downslope holding pond, discharging to the beach.

Another Wellfleet Beach without any mitigation, replacing thousands of yards of sand following another storm water erosion event. Which will need to be repeated.

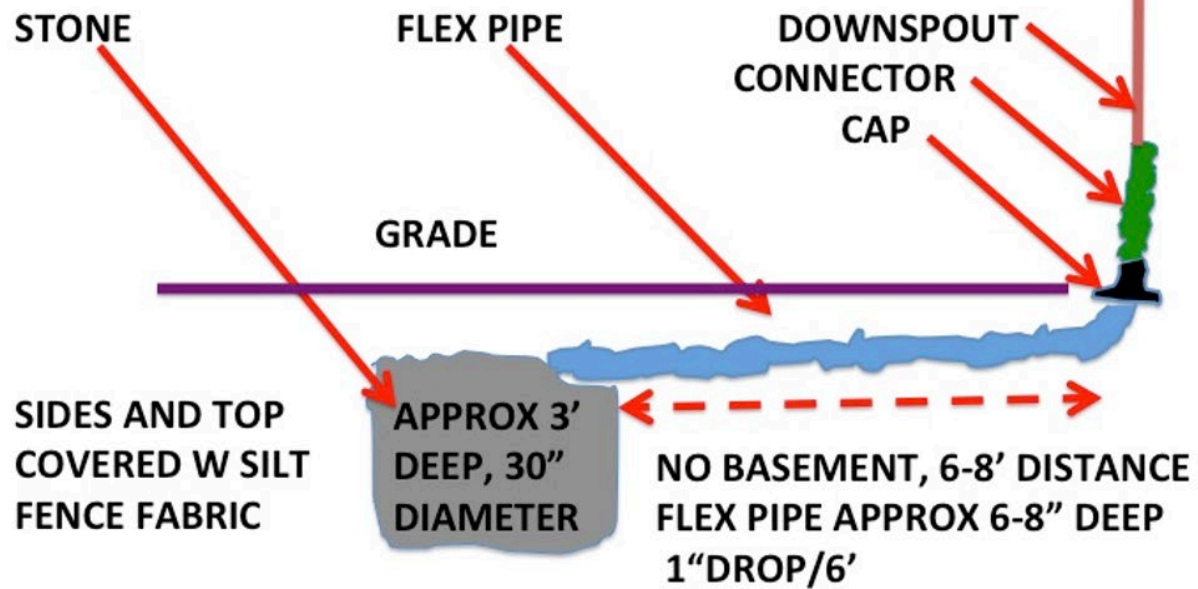


DRY WELLS are dedicated underground collection areas, for the purpose of percolating collected storm water roof runoff into the ground water table. Dry Wells are usually lined with geotextile filter fabric and filled with gravel. Roof runoff is captured by gutters, directed to downspouts and led by sloping buried tube into the dry well. A few guidelines to keep in mind: larger roofs may need multiple drywells; be sure the underground tube slopes down about 1"/6 ft; if the house has no basement, the dry well can be 6-8 feet from the foundation. If there is a basement, we move the dry well further away. Never assume the deeper the dry well the better the percolation. That is incorrect because it is the cross section which controls percolation. The depth is only necessary to accommodate water while it percolates. These systems are gravity driven, low maintenance and low profile. A gutter helmet at the top of the downspout prevents leaf litter from jamming the system. We carefully lift and then replace the surface layer of vegetation when we create Dry Wells.



Note the filter fabric over the gravel so sand does not infiltrate the system; the peeled back sod and the under burden and topsoil collected in a tarp. Ideally, dry wells would be installed prior to landscaping but a lot of people work on the sites.

Sketch of generic dry well

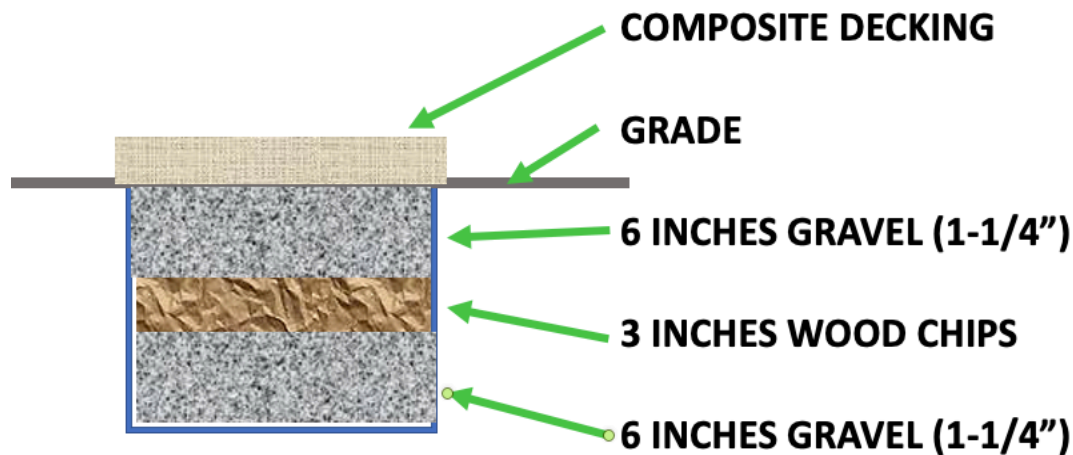


Connecting a Flex Pipe



Flex pipes, colored tape and proper connectors to flex tubing are always used.

RINSE STATIONS (SOAPLESS RINSE STATIONS)



This layered pattern should extend down 3 feet

Wood chips provide surfaces for microorganisms to safely process nutrients

The surface and inside of the recharge area should be lined with silt fabric.

The surface cross section of the recharge area should be 75% of rinse station surface.

Deck boards should have ample spacing for direct drainage.

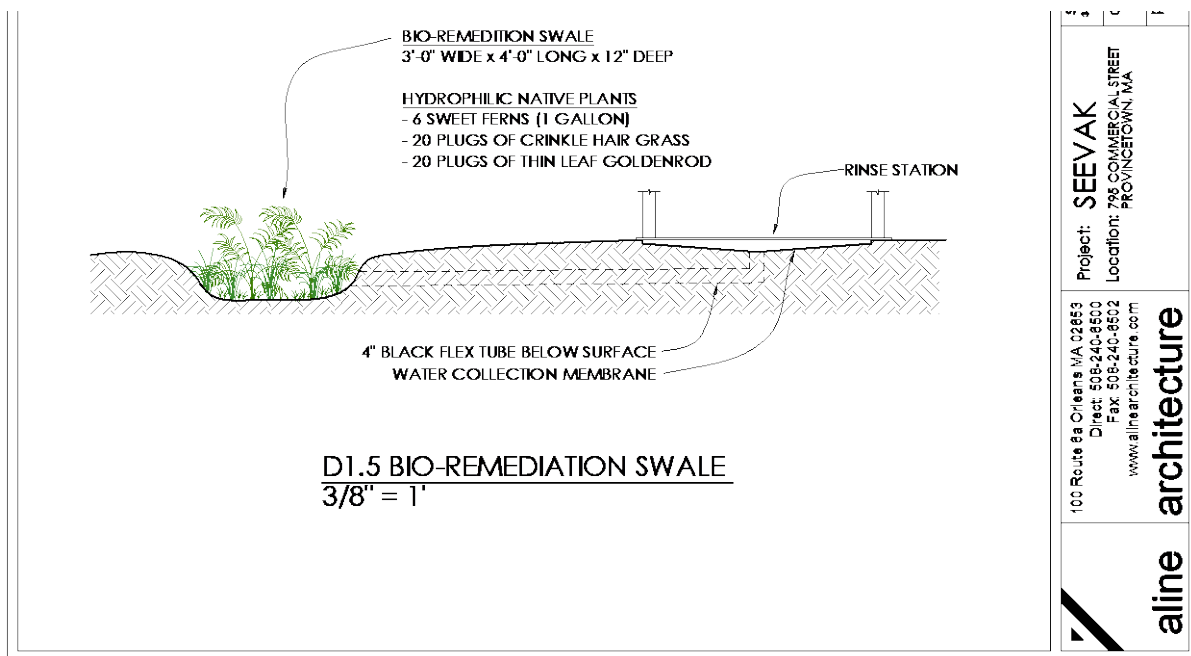
Limited open space beneath rinse station is acceptable.

An additional inch of wood chips is acceptable.

Reducing gravel by one inch is acceptable.

BIO REMEDIATION RINSE STATION

Safe Harbor collaboration with Aline Architecture



GREEN ROOFS, Safe Harbor



If an impervious surface can be fully planted, the performance standards are satisfied. A lot of sub protocols need to be considered, slope, storm event runoff, exposure and the mix of plantings that will be suitable. We begin with some gravel, over a rubber membrane. We then apply straw combined with planting mix, including Biotone micro organism infusion and some shells, which sacrifice calcium ions during acid rain events, to allow increased available nutrients. We never use fertilizers, herbicides or pesticides. Limited watering may be necessary in drought.

DRIVEWAYS:



Images by Gordon Peabody. Open Faced pavers provide infiltration and habitat. We recommend these for driveways, even those on a slope.

WALKWAYS:

Images by Gordon Peabody. The greatest objection to walkways and decks is occlusion of sunlight. “Dead zones” beneath closed surfaces are prone to erosion. Our solution to that is flow-thru decking, which allows free passage of air, moisture and sunlight onto the soil underneath. This allows groundcover to flourish, protecting the Interests of The Act by maintaining performance standards for storm water, water resources, habitat and erosion control.



This walkway also utilizes innovative/no excavation Pin Piers, which is not relevant here.

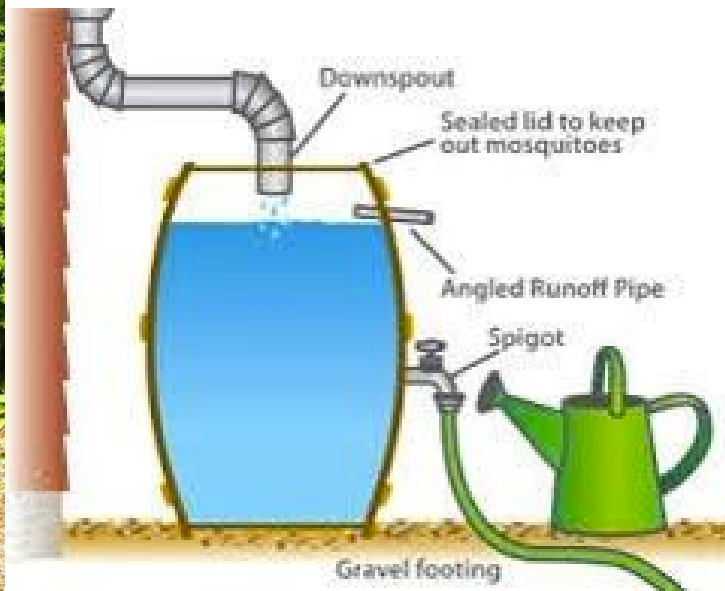




RAIN GARDENS:

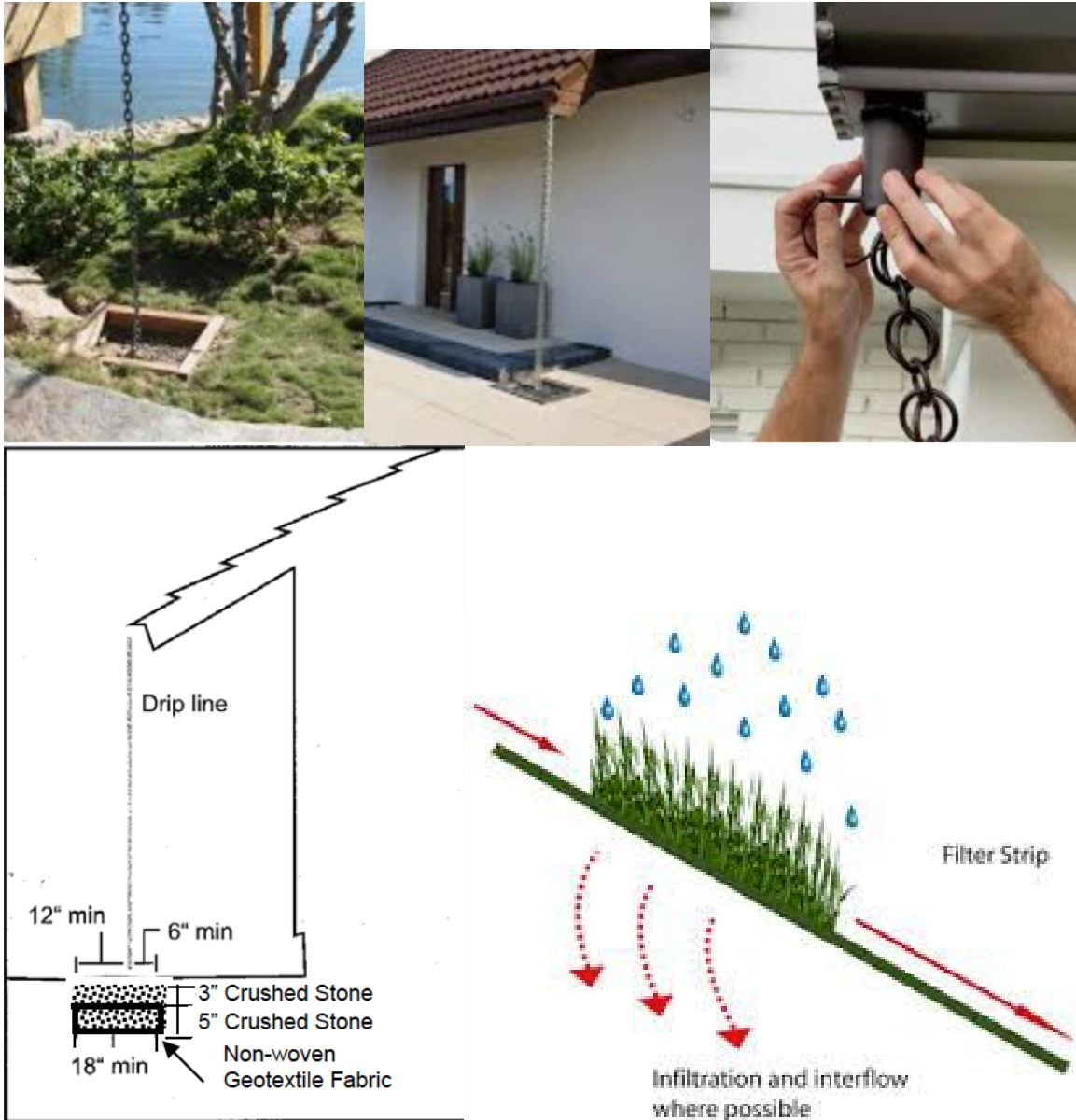


REUSING ROOF RUNOFF MEETS
PERFORMANCE STANDARDS



Dedicated lawn areas with Hydrophilic vegetation can benefit from roof runoff and both process it biologically as well as provide infiltration.

RAINCHAINS/DRIPLINES/FILTER STRIPS



These ideas are only a few of the strategies and techniques need to maintain performance standards for aggressive storm water situations. Always keep in mind, how absolutely critical it is to control upslope sheet flow, regardless of the scale of management you are attempting. Water wants to get into the water table and we have some of the best percolation rates right here on the Cape so let's use that as a tool for compliance. The failure to heed this advice has generated plenty of coffee shop discussions but we need to take initiative and advocate for using gravity driven systems to manage those tons of storm water, prior to them becoming liabilities.