Rain Gardens Slow Stormwater Flow

Grade Level: 9-12

Time: 1 - 2 class periods

Learning Objectives:

- Graphically represent precipitation, inflow and outflow of runoff in a rain garden.
- Quantify the functions of a rain garden and how it minimizes stormwater problems.
- Describe the pollutant removal functions of a rain garden.

Extension Lessons:

This lesson can be adapted for more complex calculations and excel use by using rain depth and roof area to calculate inflow to rain garden. More information on the rain garden site can be found at: http://nemo.uconn.edu/research/raingarden.htm

Rhode Island Grade Span Expectations Addressed:

Science	LS2 (9-11) - 3 Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem.	
	LS2 (9-11) – 3b	Describing ways in which humans can modify ecosystems and describe and predict the potential impact.
	LS4 (9-11) - 9 Use evidence to make and support conclusions about the ways that humans or other organisms are affected by environmental factors or heredity	
	LS4 (9-11) - 9b	Providing an explanation of how the human species impacts the environment and other organisms.
Math	Functions and Algebra	
	M(F&A)–10–2	Demonstrates conceptual understanding of linear and nonlinear functions and relations through an analysis of constant, variable, or average rates of change, intercepts, domain, range, maximum and minimum values, increasing and decreasing intervals and rates of change; describes how change in the value of one variable relates to change in the value of a second variable; or works between and among different representations of functions and relations (e.g., graphs, tables, equations, function notation).
	Geometry and Measurement	
	M(G&M)–10–6	Solves problems involving perimeter, circumference, or area of two-dimensional figures (including composite figures) or surface area or volume of three-dimensional figures (including composite figures) within mathematics or across disciplines or contexts.
Civics and Government	C&G 4: People engage in political processes in a variety of ways.	
	C&G 4 (9-12)–3	Students participate in a civil society by critically reflecting on their own civic dispositions (e.g., recognition of the capacity to make a difference)
	C&G 5: As members of an interconnected world community, the choices we make impact others locally, nationally, and globally.	
	C&G 5 (9-12) -3	Students demonstrate an understanding of how the choices we make impact and are impacted by, an interconnected world by predicting outcomes and possible consequences of a conflict, event, or course of action

Rain Gardens Slow Stormwater Flow

Name: _____ Date: _____

Purpose:

To understand and quantify how rain gardens help reduce the negative impacts of stormwater.

Things to Know:

Rain gardens are shallow depressions in the landscape that intercept, treat, and infiltrate stormwater. They are typically planted with native plants, are covered with a mulch layer, and often times look just like a regular garden you might have in your backyard. Most rain gardens are designed to capture the first one inch of rainfall flowing off a nearby impervious surface which helps to treat the majority of pollutants that are washed off in the beginning of a storm event and helps to infiltrate water.

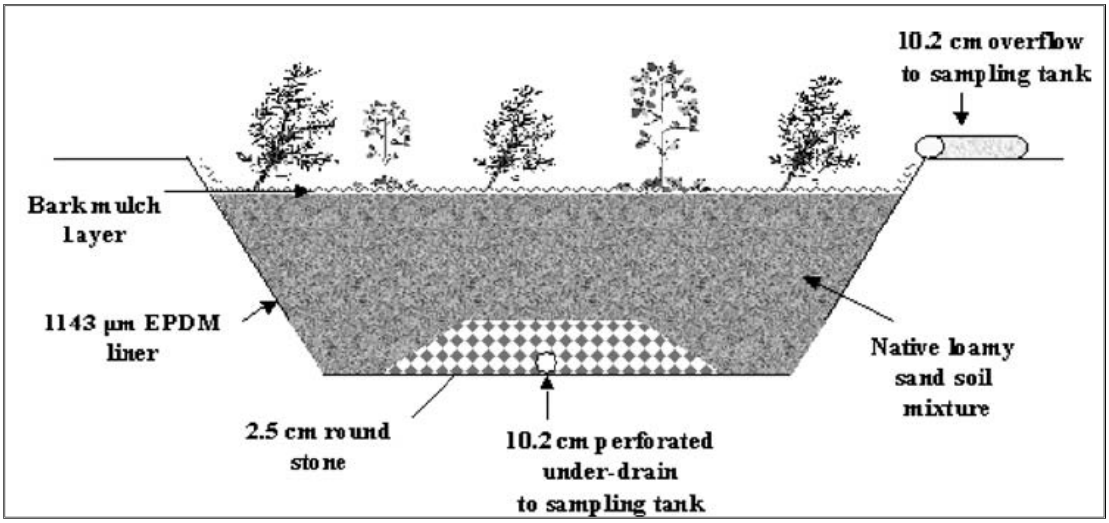
Rain gardens perform many processes that help to reduce the negative environmental effects caused by development. A research rain garden was installed in Haddam, CT in 2002 as a study done by the University of Connecticut. The rain garden was sited next to a roof downspout so as to capture the precipitation flowing off the roof. A cross section of the rain garden can be seen in the diagram below. One difference between the study rain garden and a normal one you might plant in your front yard is that it has a liner and an underdrain pipe at the bottom. This was installed so as to collect and record the volume of water captured by the rain garden and the pollutants that were removed. In a normal situation, the rain garden would allow the water to infiltrate into the natural soils below. The following information is adapted from data provided courtesy of Dr. Michael Dietz of University of Connecticut.

Roof area draining to Rain Garden = 1,150 ft^2

Rain Garden Surface area = 98.8 ft^2

Depth of Rain Garden = 6 inches

Depth of rain fall event = 0.81 inches



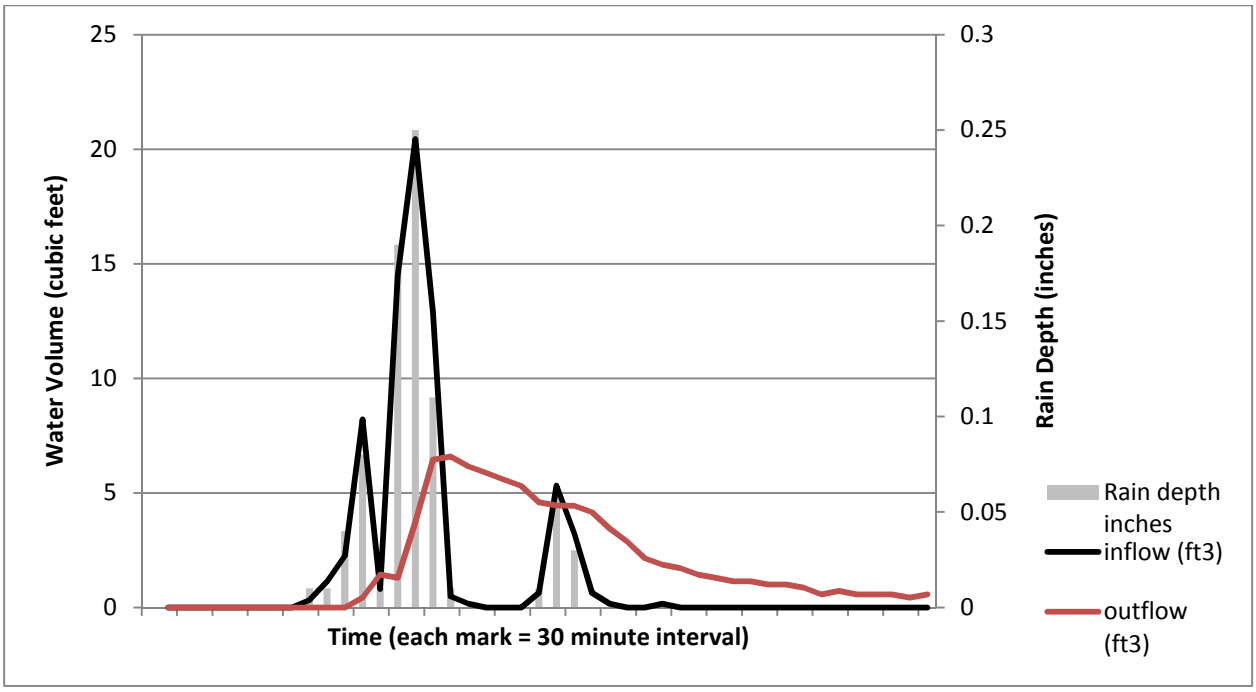
Part 1:

The following data provides information for one storm that took place at the Haddam rain garden site on October 2, 2003. The information collected at 30 minute intervals includes rain depth, inflow into the rain garden, and outflow as observed at the underdrain at the bottom of the rain garden. The source of water entering the rain garden (inflow) was a gutter connecting the top of the roof (size given above) to the rain garden. This information will help us to analyze how rain gardens impact the flow of runoff. We can use this data to observe how the volume of water moving out of the gutter, compares to the volume of water moving into the underdrain at the bottom of the rain garden.

1) Enter the following data into an excel spreadsheet or prepare a piece of graph paper and calculator to perform calculations.
2) Find the sum of the rain, inflow and outflow columns.
3) Create a graph of the data you entered. There should be three separate sets of data that you plot:
    a. Rain depth = bar graph
    b. Inflow volume = line graph
    c. Outflow volume = line graph
4) Title your axes and provide a legend for interpretation.
5) The graph should look like the example below.

Time (hr)	***Rain depth (in)***	***Inflow vol (ft3)***	***Outflow vol (ft3)***
0	0	0.000	0.000
0.5	0	0.000	0.000
1	0.01	0.322	0.000
1.5	0.01	1.127	0.000
2	0.04	2.254	0.000
2.5	0.08	8.211	0.433
3	0.01	0.805	1.431
3.5	0.19	14.490	1.292
4	0.25	20.447	3.720
4.5	0.11	12.880	6.442
5	0.01	0.483	6.589
5.5	0	0.161	6.156
6	0	0.000	5.877
6.5	0	0.000	5.583
7	0	0.000	5.305
7.5	0.01	0.644	4.586
8	0.06	5.313	4.447
8.5	0.03	3.220	4.439

Time (hr)	***Rain depth (in)***	***Inflow vol (ft3)***	***Outflow vol (ft3)***
9	0	0.644	4.161
9.5	0	0.161	3.441
10	0	0.000	2.869
10.5	0	0.000	2.150
11	0	0.161	1.864
11.5	0	0.000	1.717
12	0	0.000	1.431
12.5	0	0.000	1.292
13	0	0.000	1.144
13.5	0	0.000	1.144
14	0	0.000	0.997
14.5	0	0.000	1.005
15	0	0.000	0.858
15.5	0	0.000	0.223
16	0	0.000	0.167
16.5	0	0.000	0.050
17	0	0.000	0.030
17.5	0	0.000	0.000
18	0	0.000	0.000
18.5	0	0.000	0.000



Analysis:

1) How many inches of rain fell during this event? _____
2) What was the total water volume flowing into the rain garden? _____
3) What was the total water volume flowing into the underdrain? _____
4) If the roof has a drainage area of 1,150 ft^2, what is the volume (ft^3) of water flowing off the surface of the roof during this storm event? (*1 foot = 12 inches*)

   _____

   _____
5) What value does question #4 represent from your sum calculations completed in Part I?

   _____
6) Why do you think the total inflow was less than the total outflow of the rain garden? (*Tip: think about the area exposed to rain.*)

   _____

   _____
7) Describe some of the trends you see on your graph._____

   _____

   _____
8) How does precipitation relate to the inflow volumes with respect to time?

_____

_____

9) How does precipitation relate to the outflow volumes with respect to time?

_____

_____

10) What is the difference in peak flow between the inflow and outflow volumes?

_____

_____

11) Using your knowledge of the negative impacts of stormwater, why is the change in peak flow so important?_____

_____

_____

12) The underdrain was place in the rain garden for study purposes. Why would it be useful to have all of that water infiltrate into the soil?_____

_____

_____

Rain gardens can also treat pollutants that may be in runoff through the following processes:

a. Filtration - particles and suspended solids are filtered out in the mulch and soil
b. Assimilation – plants can take in nutrients and use them for energy and to grow
c. Adsorption – organic soils can absorb metals and nitrates with the ionic attraction of holding a substance to a solid surface
d. Degradation - microbes found in soils can degrade toxic chemical compounds
e. Transfer - bacteria found in soils can convert Nitrogen to forms that can be used by plants or released into the atmosphere.

13) What kinds of pollutants do you think you might find in stormwater runoff?

_____

_____

14) Describe how a rain garden might help solve problems in your community.

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