URBAN RUNOFF MODEL

Developed for WAV by Ron Struss and Paul Hlina.

Students will build a simple watershed model that demonstrates how the volume of stormwater runoff increases as urban watersheds are roofed and paved over.

Learning Objectives:

By participating in this activity, students will:

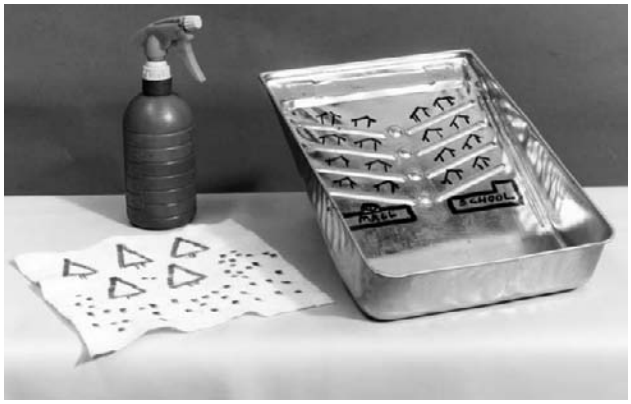
1. Demonstrate that as watersheds urbanize and increase in area under hard surfaces (e.g., roofs and pavement), the speed and volume of stormwater runoff leaving watersheds will also increase.
2. Demonstrate the need for stormwater sewers and ponds to prevent urban flooding.

Standards:

Environmental Education B.8.5, B.8.10, B.12.2, B.12.3, D.8.5

Time:

25 minutes



Materials:

- A paint roller tray
- A spray bottle
- A 10” X 10” square of white felt
- Green, blue and black permanent markers
- Cloth or paper towels
- Measuring cup
- Extra felt (optional)
- Modeling clay (optional)
- Tape

Background:

Why do cities have storm sewers? Why are streams in urban areas usually in poor condition? Why are cities starting to install more stormwater runoff ponds?

The one answer to all the above questions is: Impervious surfaces. Impervious surfaces are hard surfaces like roofs, roads and parking lots into which that water cannot soak.

Urban areas are covered with impervious surfaces. They are what make a city a city and not the countryside. In fact, urban areas are often defined by the amount of ground that is covered by "streets, shingles and sidewalks." (See table on page 1-71.)

Stormwater runoff is the water that runs off the surface of the ground during rainfall or snow melt. As a watershed (the area of land that drains to a lake or stream) becomes urbanized and covered with impervious surfaces, the amount of stormwater runoff also increases. This is because:

1. Impervious surfaces prevent stormwater from reaching the soil. Soil acts like a big sponge, soaking up runoff water. When soil is covered by hard surfaces, water can no longer soak in, increasing the amount of surface runoff.
2. Land is reshaped when buildings, roads and parking lots are built in order to speed stormwater drainage. Areas where stormwater once puddled are eliminated, which leads to increased amounts of runoff flooding streets and parking lots. Stormwater sewer systems are installed in cities to drain stormwater from paved areas to nearby lakes and streams. Unless redesigned to have a larger floodplain, streams can only handle a set amount of water.

When urbanization increases the amount of runoff, streambanks are often eroded away as the increased volume of water and speed of runoff push against them.

PROCEDURE:

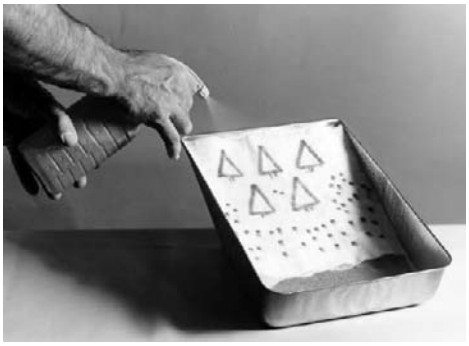
How to make the model:

1. Using a black permanent marker, illustrate the sloped area of the paint roller tray with an urban scene complete with houses, schools, stores, streets and parking lots. Write the word "stream" at the flat bottom area of the tray with a blue marker.
2. Cut a piece of felt to fit over the sloped area of the paint roller tray. Using a green permanent marker, draw a scene of natural vegetation on the felt. It is best to use white felt or paper towels as dyes may "run" when wet.
3. Adjust the spray bottle so that it sprays an area smaller that the width of the tray. Getting water on the sides of the tray should be avoided.

How to use the model:

1. The paint roller tray is a watershed; the bare tray is an urban watershed with 100% impervious surfaces, the tray with felt cover is a natural vegetated watershed with 0% impervious surfaces. Just like soil, the felt acts like a sponge soaking up stormwater. The flat bottom area of the paint roller tray is a stream that receives stormwater runoff. The spray bottle is rain.

2. Create "rain" on the natural vegetation watershed. Place the felt over the sloped area of the paint roller tray. Spray the felt with even sprays while counting the number of sprays. Record the number of sprays it took to get one drop of runoff from the "natural vegetated watershed" into the "stream" (it should take 75-100 sprays).



Making rain on the "natural vegetation watershed" (number of sprays are counted).

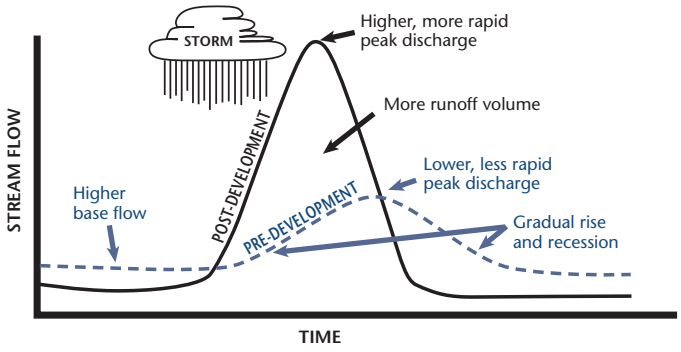
3. Remove the felt and dry out paint roller pan. Pretend the natural vegetated watershed has been dramatically converted into an urban watershed with 100% impervious surface. Make bulldozer noises if you like as the felt is removed and the urban scene is revealed. Point out that this is a dramatic illustration; going directly from a fully naturally vegetated watershed to a fully urbanized one will take some time in real life.

4. Create "rain" on the urban watershed. Spray the sloping area of the bare metal paint roller pan with even sprays. Count the sprays it takes to get one drop of runoff from the "urban watershed" into the "stream" (it should only take 3 to 5). Continue spraying until the spray count is the same as what produced a single drop of runoff in the "naturally vegetated" watershed. How much water is in the stream?

Making rain on the "urban" watershed (number of sprays are again counted).

5. Compare the two – discuss. It should be obvious that urbanization results in faster runoff and more runoff. Discuss what the impact on the receiving stream would be as the speed and volume of stormwater runoff from a watershed increases. Discuss ways that stormwater runoff speed and volume can be reduced from urban watersheds.

A hydrograph is a graph that shows stream flow over time. This hydrograph shows how stream flow changes as a watershed goes from a natural land cover (pre-development) to an urbanized land cover (post-development).



Urban Land Use	Percent Area in Impervious Surfaces
Downtown areas or shopping malls	95% - 100%
Apartments or closely-spaced houses	45% - 60%
Suburban houses on typical lots (¼ acre)	35% - 45%
Suburban houses on large lots	20% - 40%
Open park areas	0% - 10%

Source: Modified from the Wisconsin Stormwater Manual, Department of Natural Resources

Discussion Question:

1. What actions could individuals and communities improve land use in the watershed?

Other ideas:

Add Green Spaces

Cut small pieces of felt (e.g., 2" X 3") and stick this onto the "urban watershed" with rolled tape. These represent parks, playgrounds, golf courses and yards in urban areas. Spray the watershed a set number of times before and after the felt squares are in place and see how the addition of "green" spaces in cities affects the volume of stormwater runoff.

Add Stormwater Ponds

Using modeling clay, construct a number of "U"-shaped dikes on the "urban watershed" where the "V"-shaped ridges come together in the center of the tray. These dikes represent stormwater ponds built at the end of storm sewer lines. Do a set number of sprays, drying out the ponds with towels afterwards to represent pond water that infiltrates into the soil or evaporates. Measure the remaining runoff in the "stream" and see how the addition of stormwater ponds affects the volume of stormwater runoff.

Resources

Chapter One, The Wisconsin Stormwater Manual, UW-Extension Publication G3691

Storm Sewers – The rivers beneath our feet, UW-Extension Publication GWQ-004