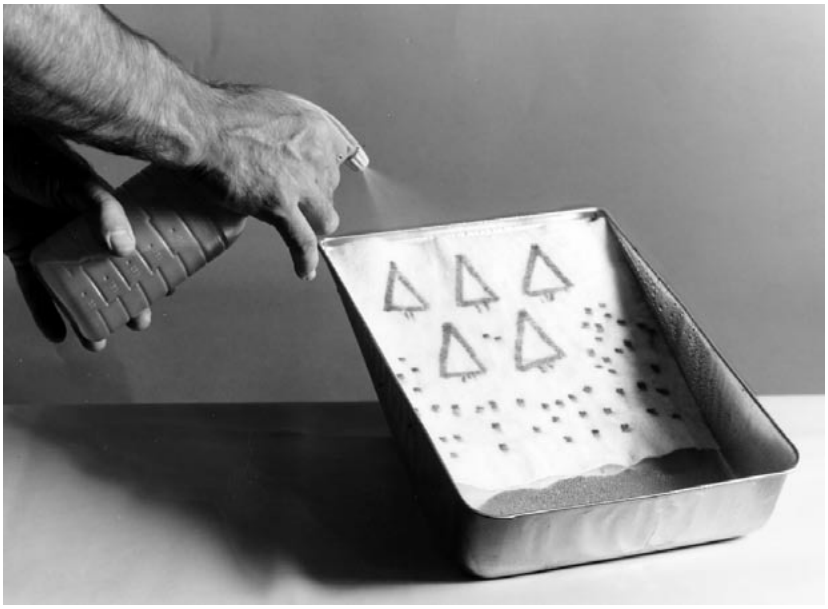
Urban Runoff Model

DESCRIPTION:

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



OBJECTIVES

By participating in this activity, your group will:

1. Demonstrate that as watersheds urbanize and increase in area under hard surfaces (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.

TIME

The urban stormwater runoff model is easy to build and takes approximately 10 minutes to construct once the materials are at hand. The simplest demonstration with the model can be done in less than 15 minutes.

AGE

The model has been successfully used for groups ranging in age from seven years old to adult. Stormwater runoff is something that most of us do not think about, making the model useful for adults and children.

COST

Approximately $10.00; less if items are borrowed from home or other sources.

YOU WILL NEED:

- 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 that water can not soak into.

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 back page.)

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. Streams in particular are naturally designed to handle a set amount of water. When urbanization increases the amount of runoff, streambanks are in a constant state of erosion to handle the increased volume of water.

(Use the back page as an overhead or handout to show impervious surfaces and demonstrate stream flow rates.)

HOW TO MAKE THE MODEL

1. Illustrate paint roller tray

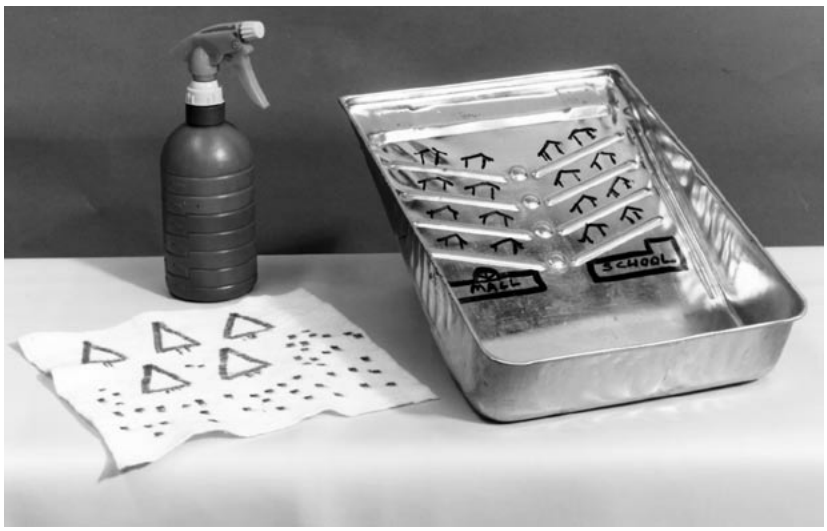
Using a permanent marker (black), illustrate the sloped area of the paint roller tray with an urban scene complete with houses, schools, stores, streets, and parking lots. Write the word "stream" at the flat bottom area of the tray with a blue marker.

2. Cut and illustrate square of felt.

Cut a piece of felt to fit over the sloped area of the paint roller tray. Using a permanent marker (green), 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. Fill and adjust the spray bottle.

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. Define the parts

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. 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).

3. Remove the felt and dry out paint roller pan

Say that 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.

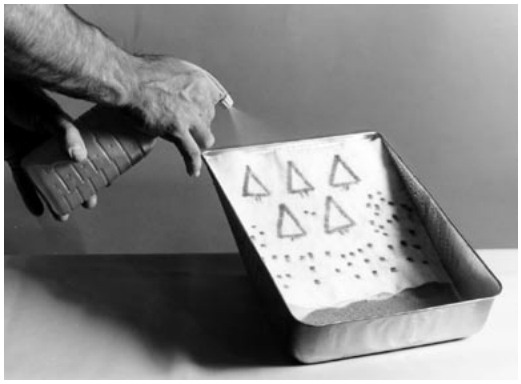
4. Rain on the urban watershed.

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?

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.



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

Other ideas:

Add green spaces.

Cut small pieces of felt (e.g., 2" X 3") and stick on "urban watershed" with rolled tape. These represent parks, play-grounds, golf courses, and yards in urban areas. Do a set number of sprays 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.

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

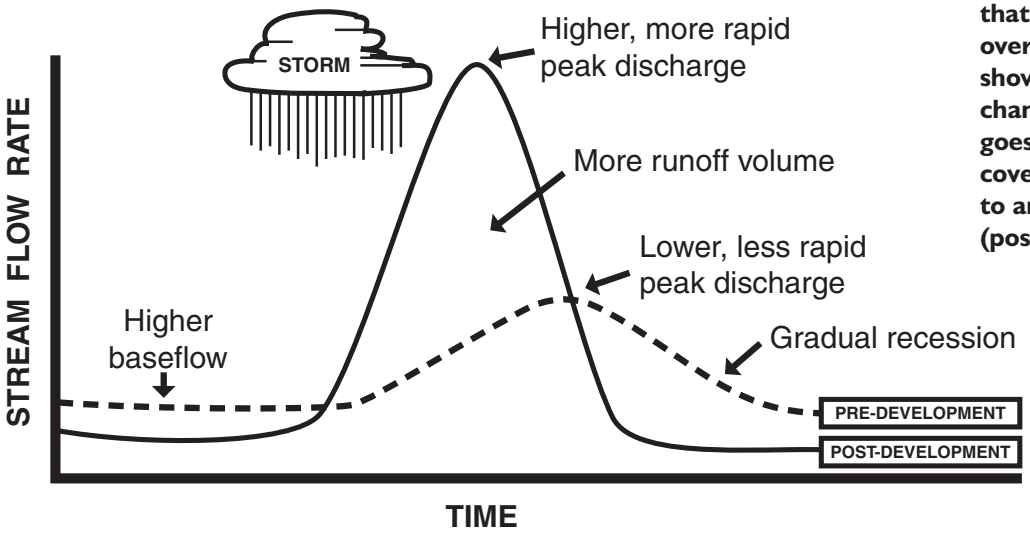
Add Stormwater Ponds.

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.

The table below shows percentages of impervious surfaces for different types of urban land use:

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 (1/4 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



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).

RESOURCES

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

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

Stormwater Ponds – An effective way to control urban runoff, UW-Extension Publication GWQ-017

Check the Resources Unit for an order form for these publications.

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Water Action Volunteers is a cooperative program between the University of Wisconsin–Extension and the Wisconsin Department of Natural Resources. For more information, contact the Water Action Volunteers Coordinator at 608-264-8948.