



## **The Eight Tools of Watershed Protection**

Tom Schueler  
Center for Watershed Protection  
**EPA Webcast**



# About the Center for Watershed Protection



- ◆ Non-profit 501(c)3, non-advocacy organization
- ◆ Work with watershed groups, local, state, and federal governments
- ◆ Provide tools communities need to protect streams, lakes, and rivers
- ◆ 20 staff in Ellicott City, MD
- ◆ [www.cwp.org](http://www.cwp.org)
- ◆ [www.stormwatercenter.net](http://www.stormwatercenter.net)



- **Watershed Research**
- **Watershed Practices**
- **Watershed Applications**
- **Watershed Learning**
- **Watershed Capacity**



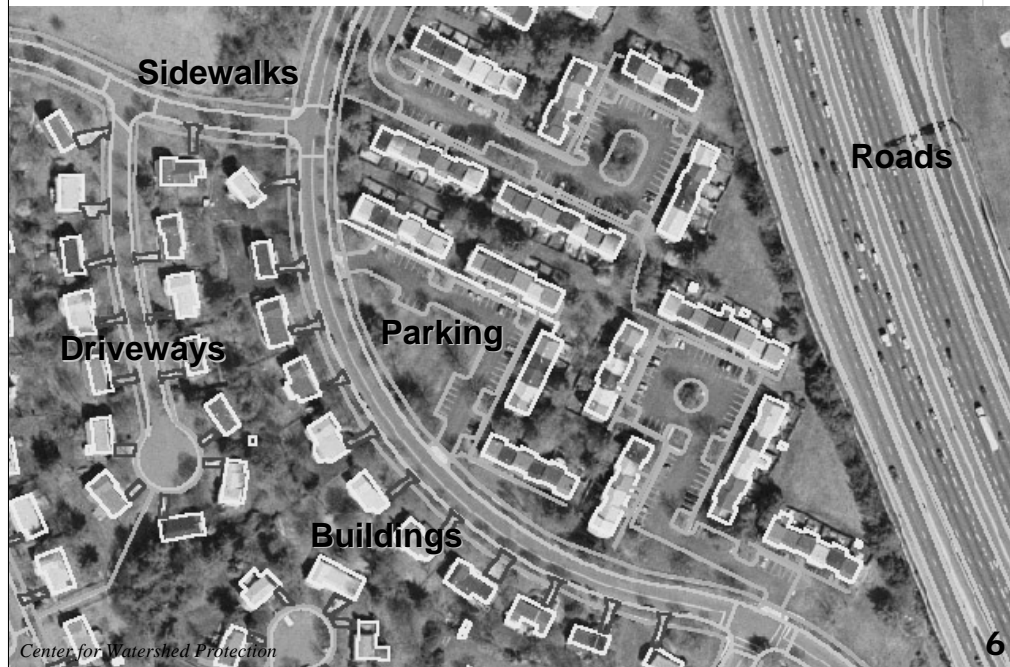
## Key Themes

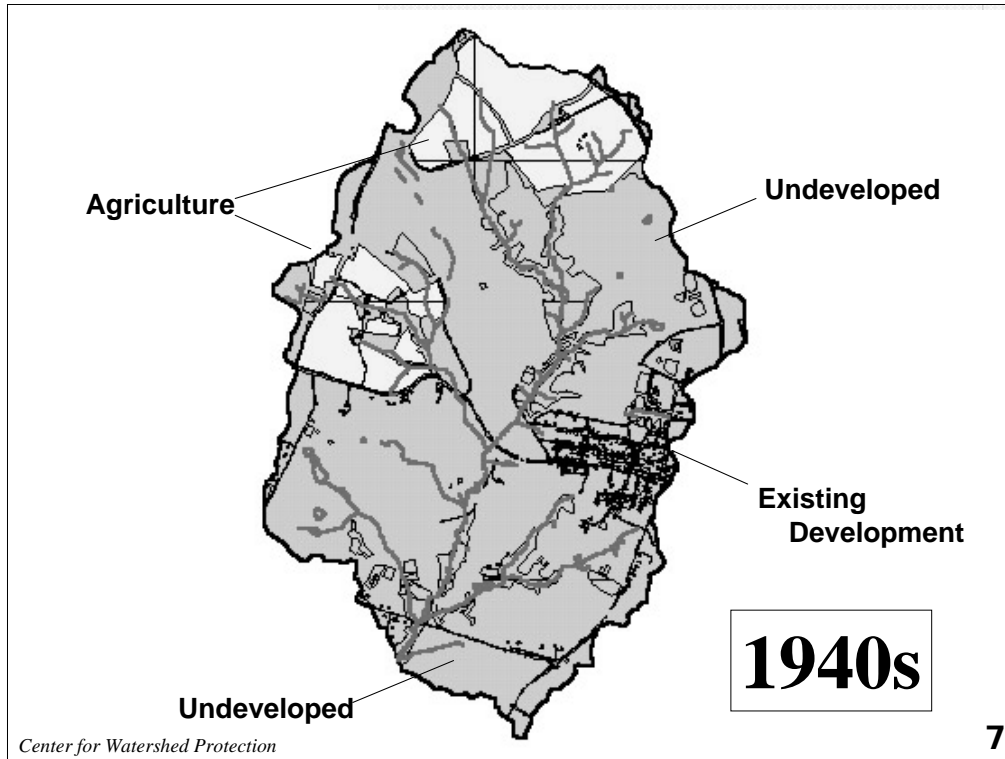
1. Relationship between impervious cover and stream quality
2. 8 tools to protect streams from development
3. CWP Watershed Behavior Quiz



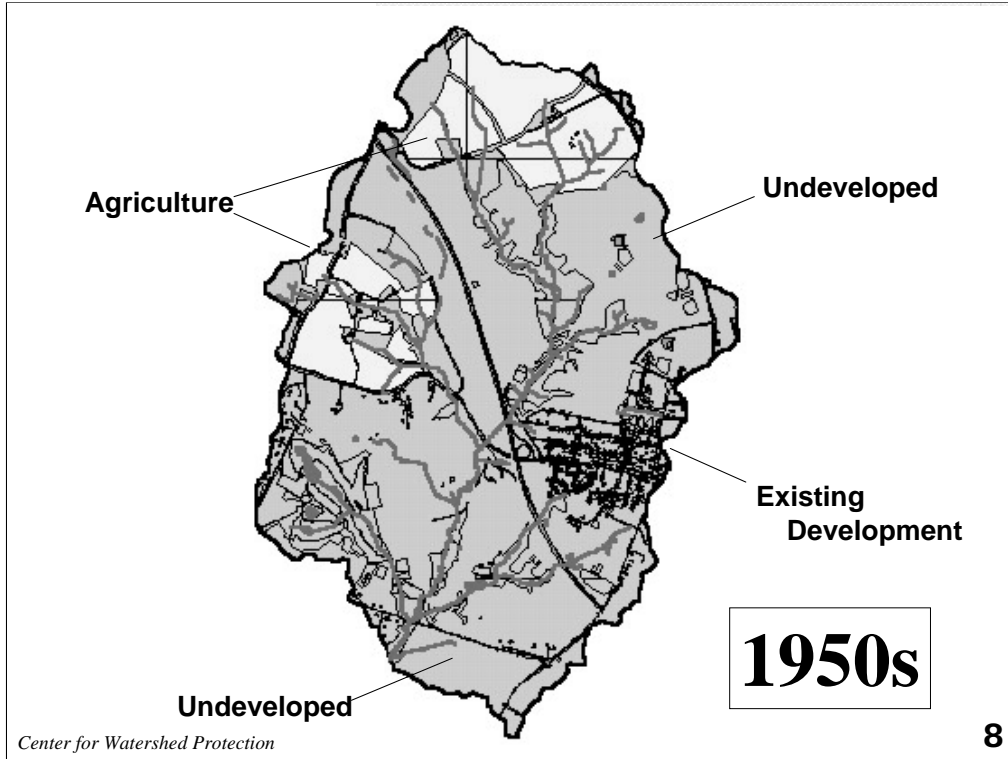
**5**

## Components of Impervious Cover in the Urban Landscape

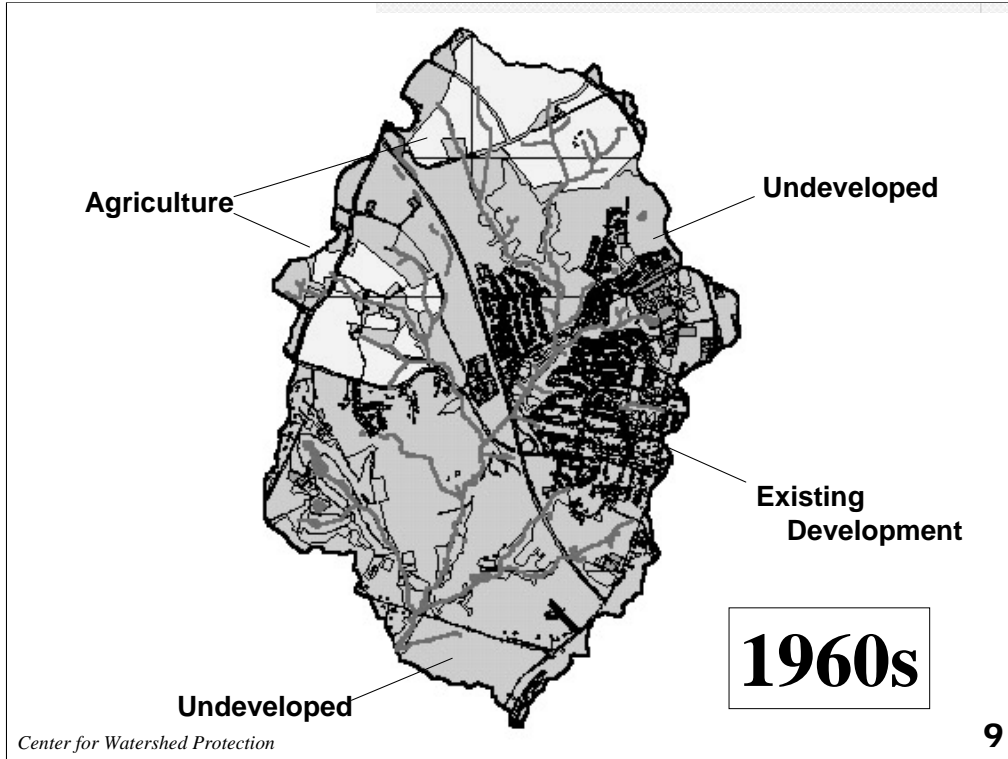


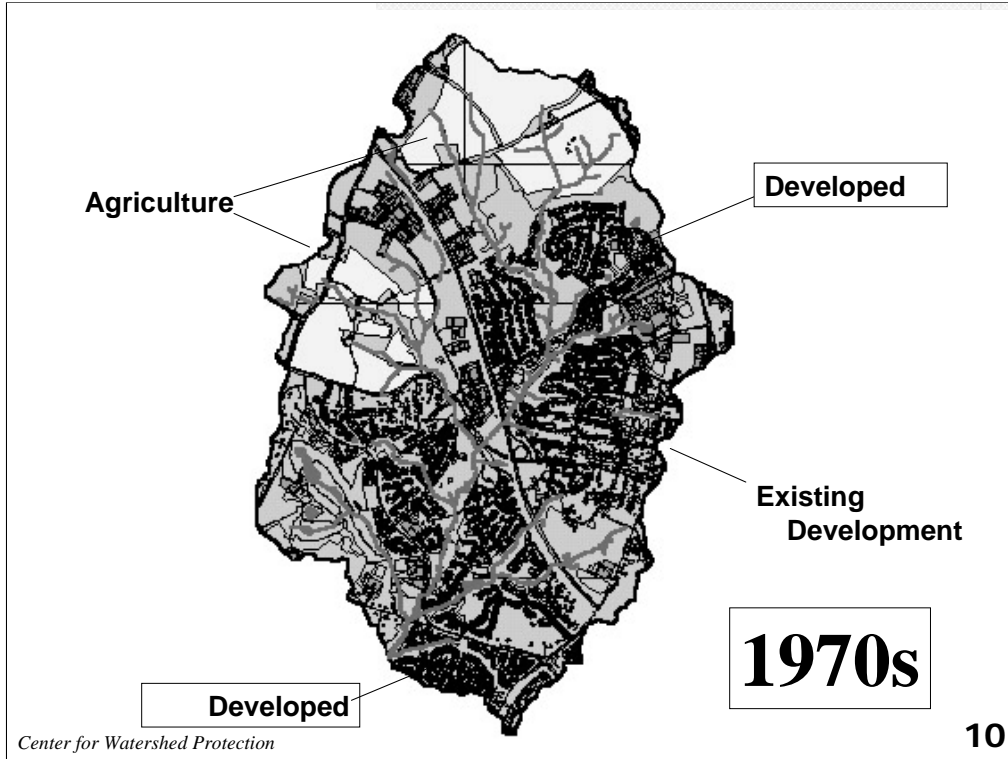


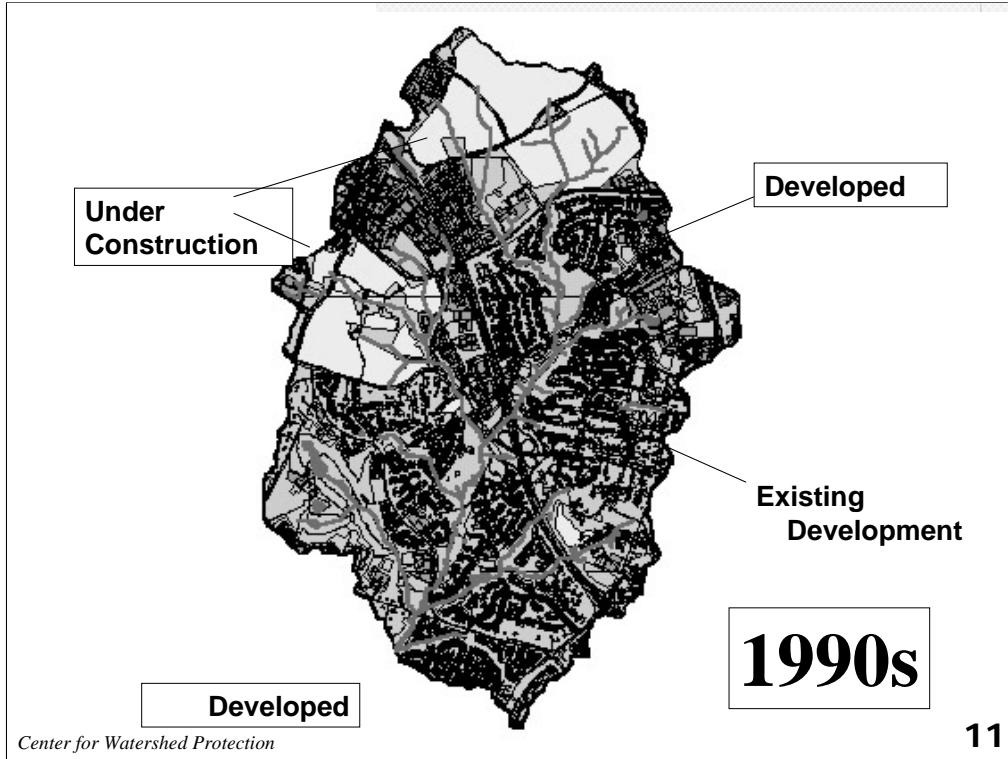
Unless effective zoning and planning is put into place, a watershed can become builtout in a relatively short time span. This particular illustrates the rapid development of a watershed over just a few decades. Notice the jump in the amount of development that occurred in the watershed from the 1960s to 1970s.

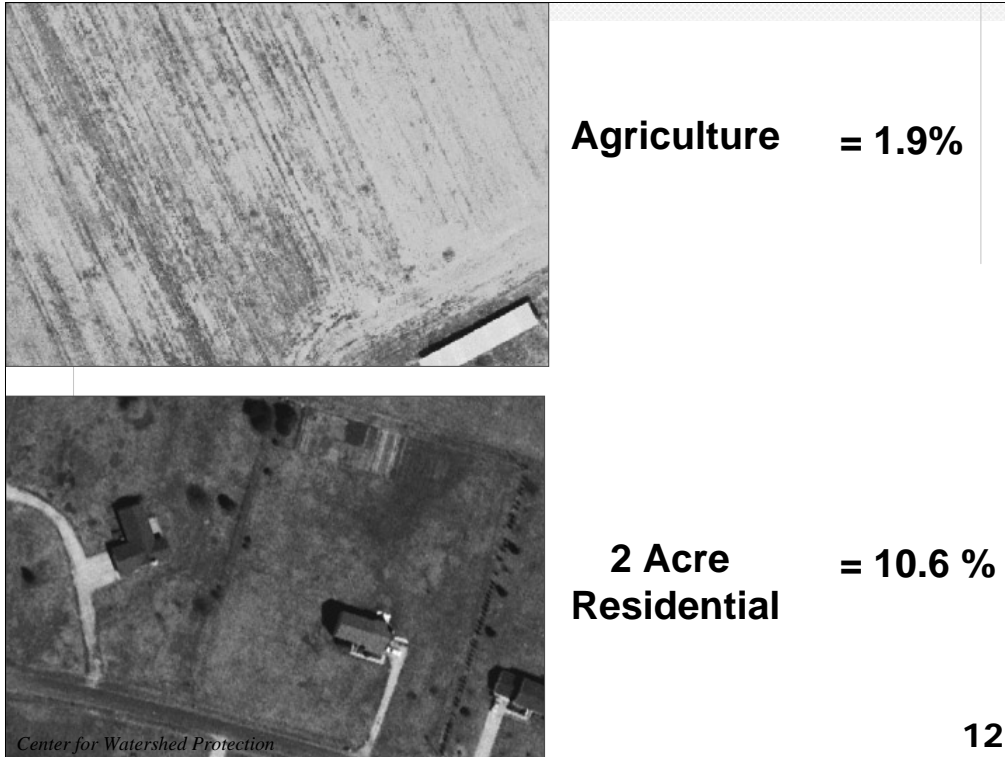












Land Use and zoning categories can be used to predict and estimate the amount of impervious cover. For an area zoned, agriculture, you can expect this area to have an impervious cover percentage around 1.9%. A subdivision that has 1 dwelling unit per 2 acres is about 10.6% impervious. As you can see, it doesn't take a whole lot of development to reach 10%.



**1 Acre  
Residential = 14.3 %**



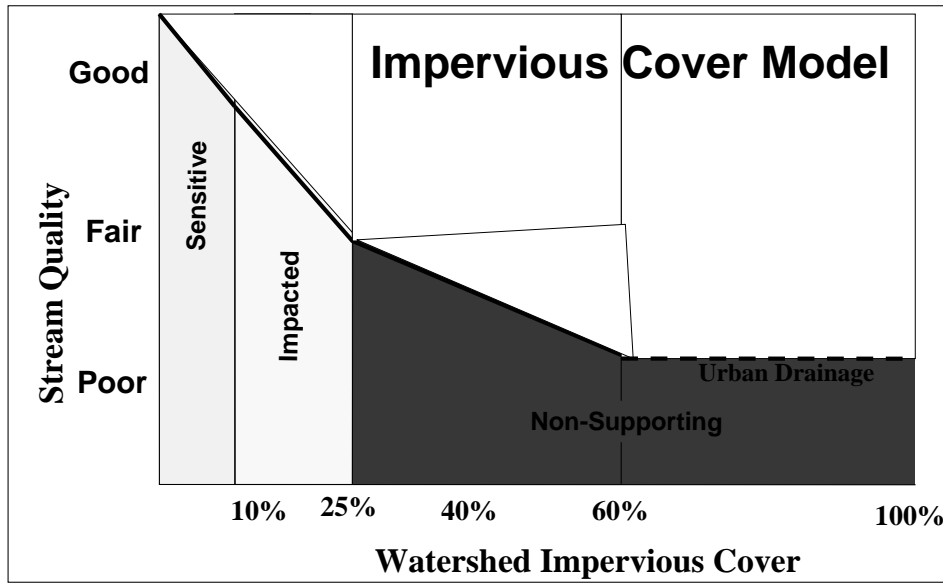
**1/2 Acre  
Residential = 21.2 %**



**Light Industrial = 53.4 %**



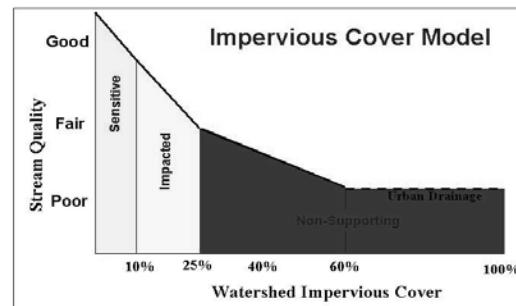
**Commercial = 72.2 %**



## ICM Disclaimer

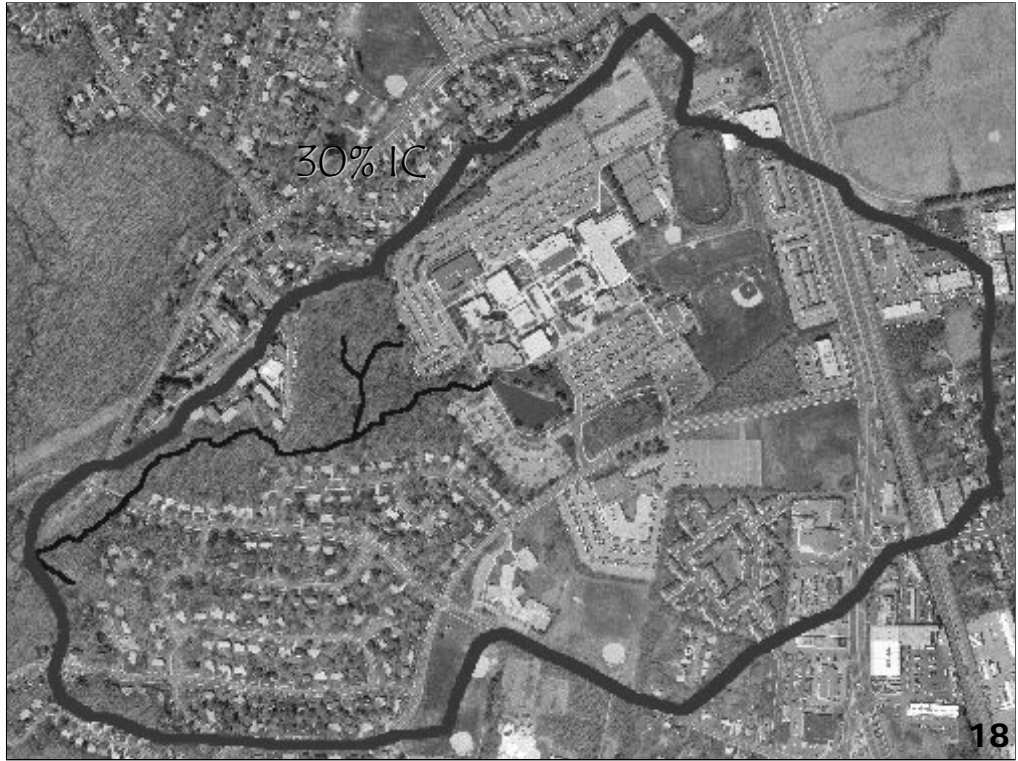
**"ICM predictions are general, and may not fully apply to every stream. Factors such as stream gradient, stream order, stream type, age of subwatershed development, prior land use, past management practices can and will make some streams depart from these predictions"**

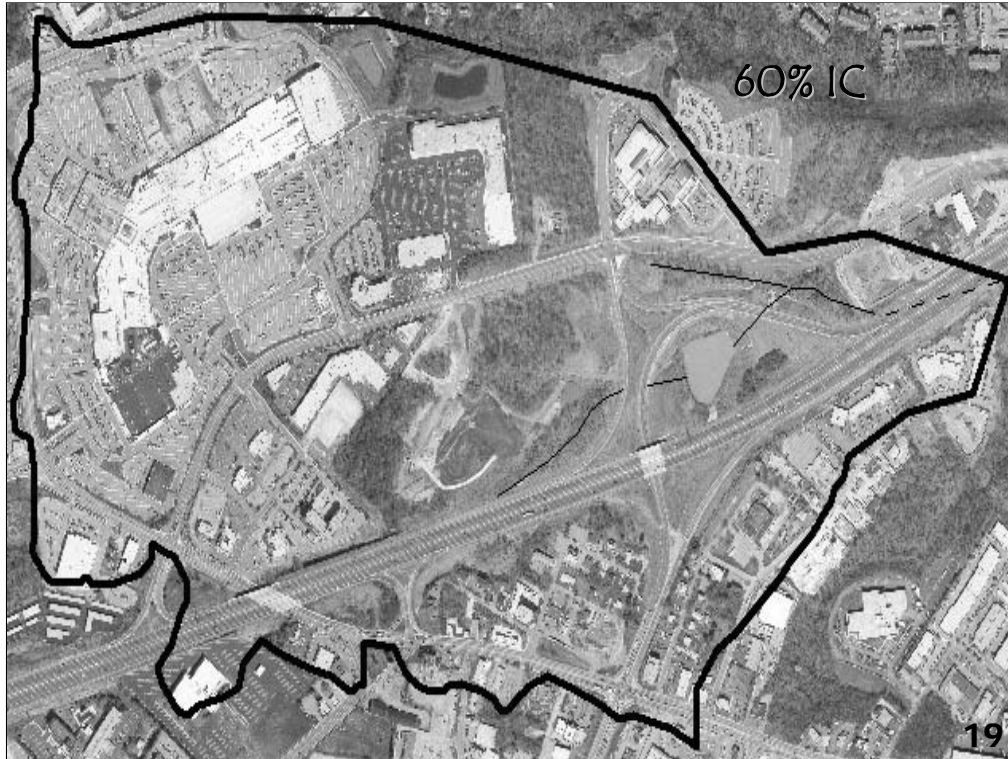
**Must be 18 or older to enter.  
Not valid in TX, UT and  
AK. APR of 6.15%. Not  
everyone qualifies for special  
financing. Offer may  
restricted due to Acts of God.  
You can never win. Center  
not liable for any damages, we  
don't have any \$ even if we are**















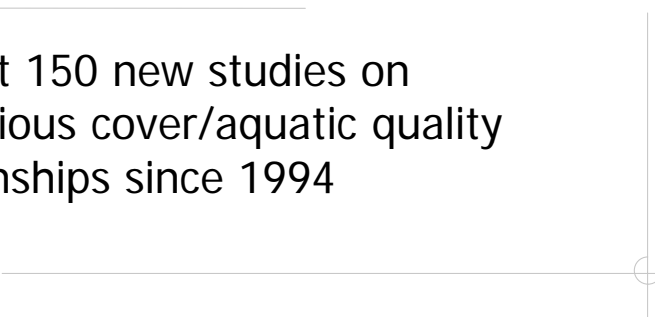
Discussion Time:

What are the issues involved in measuring and projecting impervious cover?



## Review of Recent Research

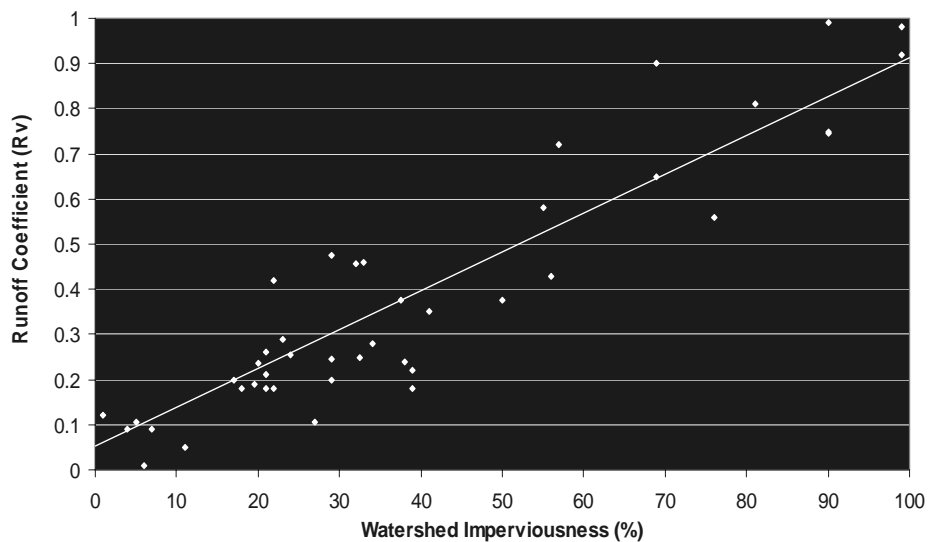
At least 150 new studies on  
impervious cover/aquatic quality  
relationships since 1994



## Hydrological Indicators

- ◆ Increased stormwater runoff
- ◆ Increased frequency of flooding
- ◆ Floodplain expansion
- ◆ Diminished baseflow
- ◆ Increased bankfull flooding

Relationship Between Watershed Imperviousness (I)  
and the Storm Runoff Coefficient (Rv)  
(Source: Schueler, 1987)







*Copyright 2000, Center for Watershed Protection*

## Physical Indicators

- ◆ Loss of headwater streams
- ◆ Floodplain encroachment
- ◆ Loss of intact riparian buffer
- ◆ Stream interruption
- ◆ Increased number of crossings/fish barriers

## Stream Habitat Indicators

- ◆ Channel enlargement
- ◆ Increased sediment load
- ◆ Declining stream habitat scores
- ◆ Large woody debris
- ◆ Stream warming

## IC and Stream Habitat



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This slide illustrates how impervious cover can alter the geomorphology of a stream channel.

In watersheds with less than 5% impervious cover, streams are typically stable and pristine, provide a variety of habitats, maintain a diverse aquatic population and have good tree coverage.

While this stream at 8-10% Impervious Cover is still relatively stable signs of stream erosion are more apparent, and there is some loss of good habitat.

The surrounding area of this stream is approximately 20% impervious cover. Stream erosion is much worse than in the previous slide due to an absence of vegetation to hold together bank structure. The amount of erosion has been so great that the drain pipe that once rested on the stream bottom is now 2 feet above the water.

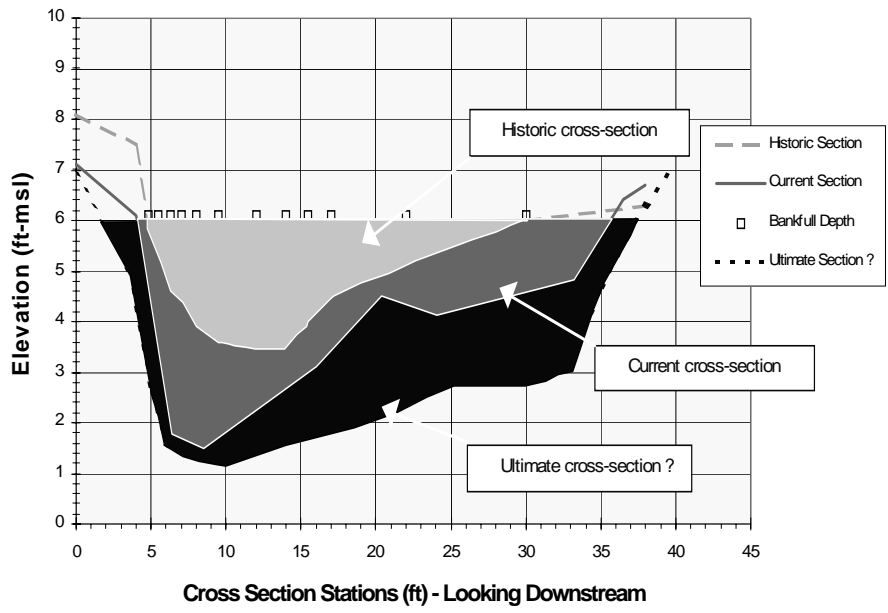
This stream has a surrounding area of approximately 30% impervious cover. The channel is deeply cut down, there is little to no bank vegetation to prevent erosion, and there is little habitat structure.

Above 65% impervious cover, the stream geomorphology is typically completely destroyed by channelization. Concrete or pipes provide little to no habitat and support little to no aquatic organisms.

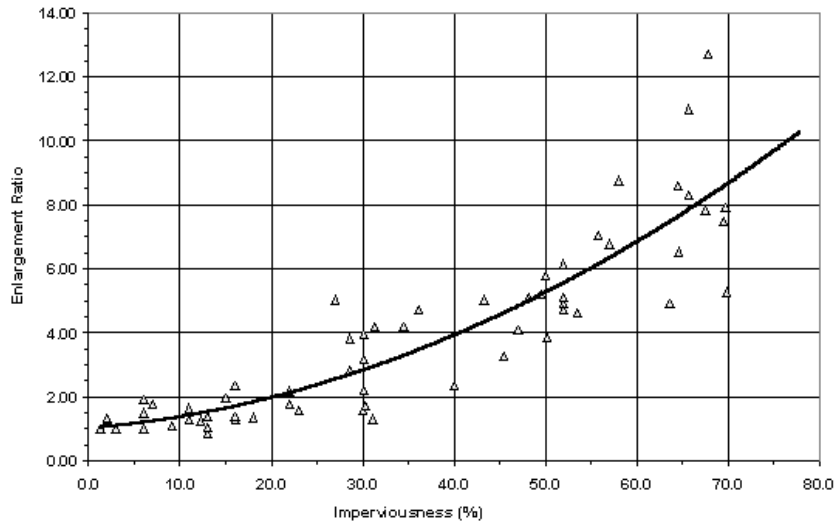


Source: Leopold, 1994





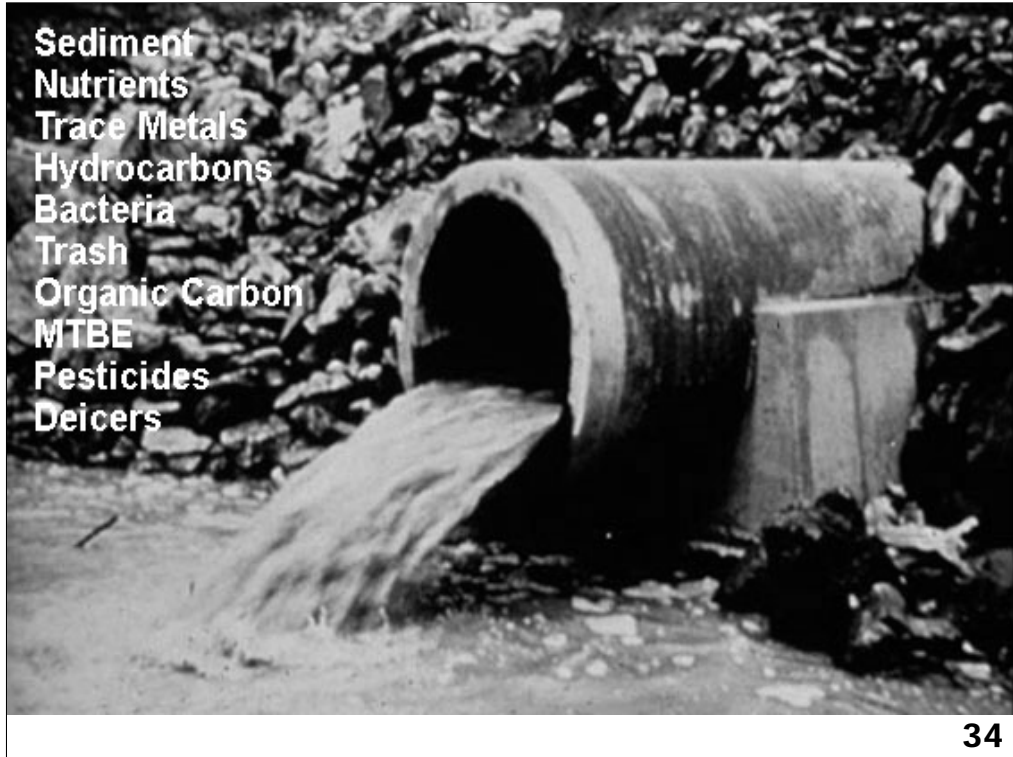
# Channel Enlargement as a Function of Impervious Cover





## Water quality indicators

- ◆ Violations of Bacteria standards
- ◆ Nutrients and eutrophication
- ◆ Aquatic life toxicity
- ◆ Sediment contamination
- ◆ Trash and debris loads



# Aquatic Diversity Indicators

- ◆ Aquatic Insect Diversity
- ◆ Sensitive Insects
- ◆ Fish Diversity Scores
- ◆ Trout and Salmon
- ◆ Wetland and Floodplain Plant Diversity
- ◆ Amphibian Diversity



Discussion Time:

What is the scientific basis for the ICM model?

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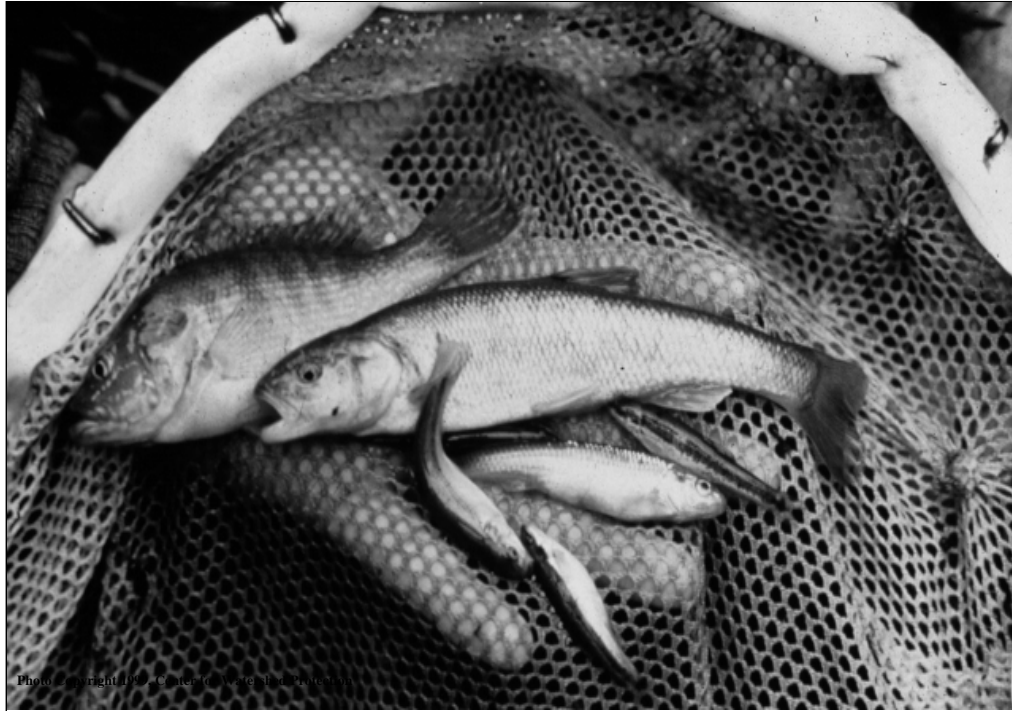
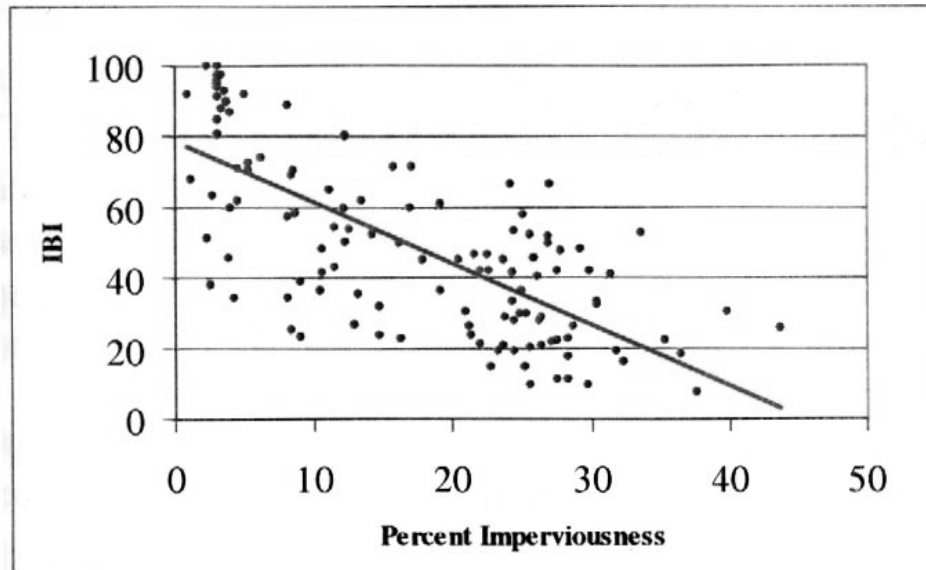


Photo copyright: Photo Center, Inc. (1998)

## Index of Biological Integrity vs. Impervious Cover



(Fairfax County, 2001)

## IC also associated with:

Urban heat islands...vehicle pollutant emissions...PAH and metal levels in sediments...forest fragmentation...loss of streamside forest cover...Increased risks of spills, leaks, illicit discharges, illegal dumping and sewer overflows...bacteria sources...shellfish and beach closure...and many other factors



## Other Watershed Indicators

- ◆ Watershed forest cover (65%)
- ◆ Streamside forest cover (65% of network)
- ◆ Watershed turf cover (?)
- ◆ Road density

**The 8 Tools  
of Watershed  
Protection**

1. Watershed Planning

2. Land Conservation

3. Aquatic Buffers

4. Better Site Design

5. Erosion & Sediment Control

6. Stormwater Management

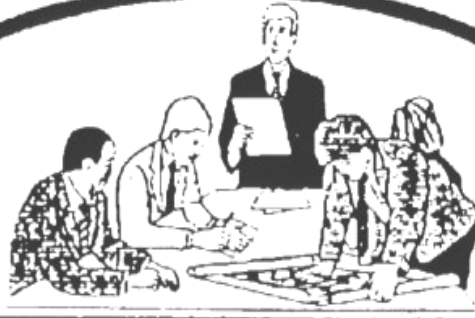
7. Non-Stormwater Discharges

8. Watershed Stewardship

*Center for Watershed Protection*

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Communities have found that no matter what watershed they are working in, the same 8 basic management tools are needed to mitigate the impacts of development: watershed planning, land conservation, aquatic buffers, better site design, erosion and sediment control, stormwater management, non-stormwater discharges, and watershed stewardship programs.



WATERSHED  
PLANNING  
1

## Management Implications

- ◆ Small watershed application
- ◆ Subwatershed classification
- ◆ Adapting the 8 tools for each type of watershed
- ◆ Need to measure watershed treatment

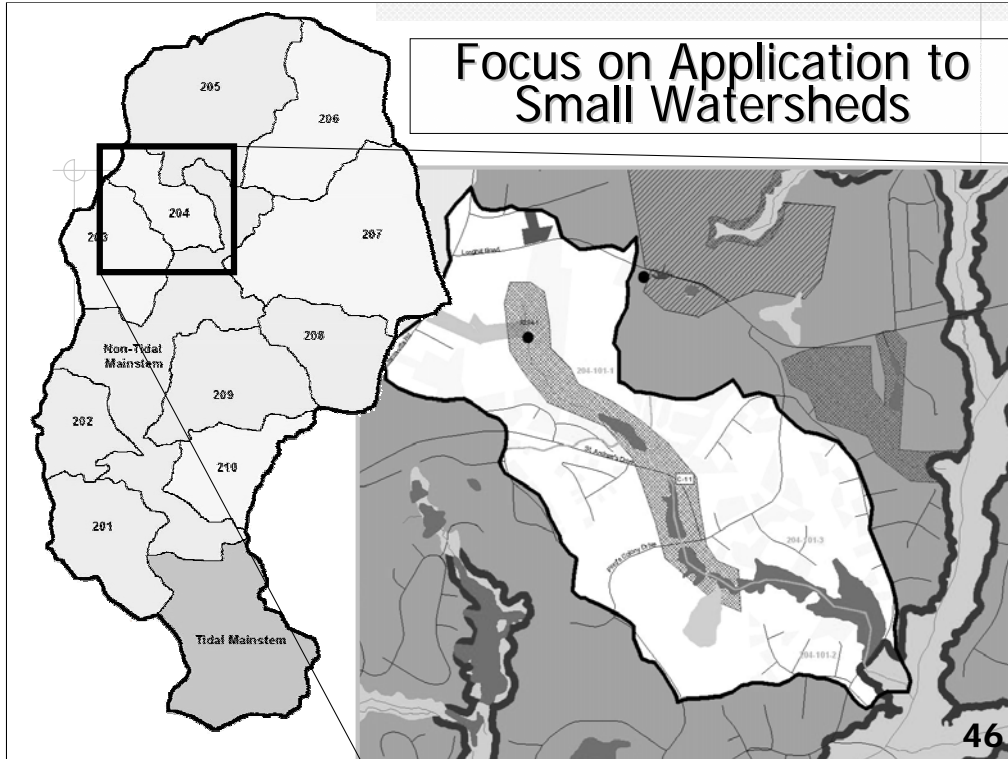


Discussion Time:

What are the planning implications of the ICM Model?

Are other watershed indicators helpful?

# Focus on Application to Small Watersheds



## Sensitive Streams

2 to 10% IC

- ◆ Most indicators in the good to excellent range.
- ◆ Not automatic, indicators will decline if poor land management practices exist in the subwatershed
- ◆ Some individual indicators are more sensitive and start to decline at 5 to 10% IC
- ◆ Other subwatershed metrics may have more predictive ability (forest cover, RFC, Turf cover)



## Sensitive Streams



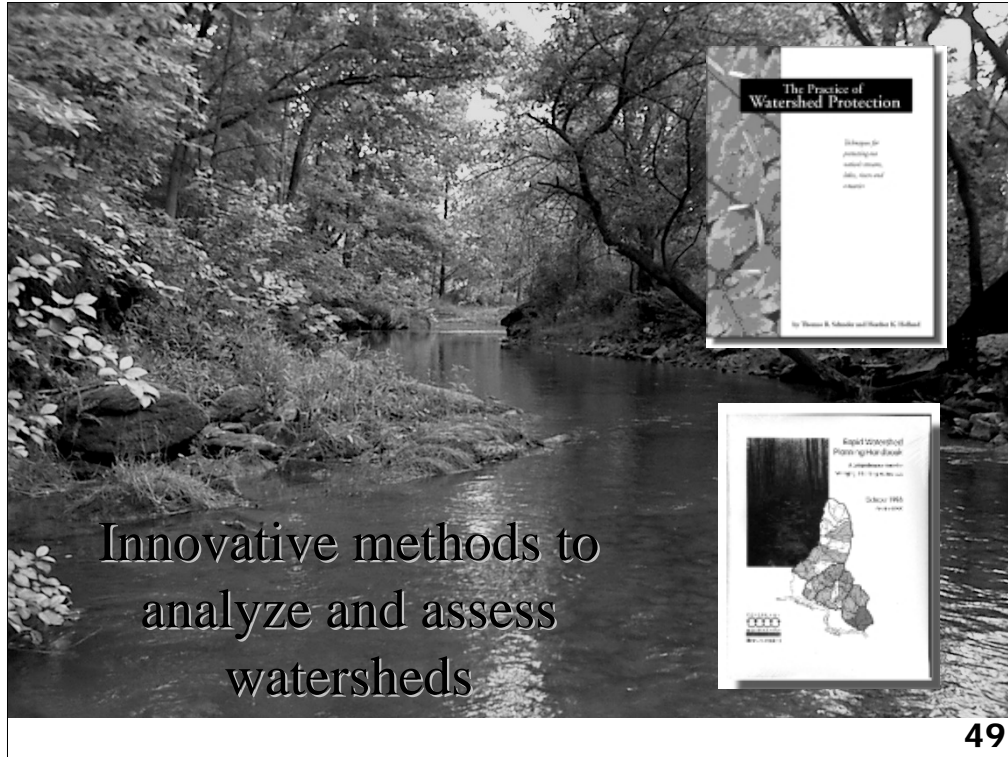
Key Planning Issue:

**Predicts that even low intensity residential development will degrade streams even with watershed treatment**

Response:

**Aggressive down-zoning, land conservation, and buffers. No sewers. ICM is defensible, but only apply to most critical resources.**





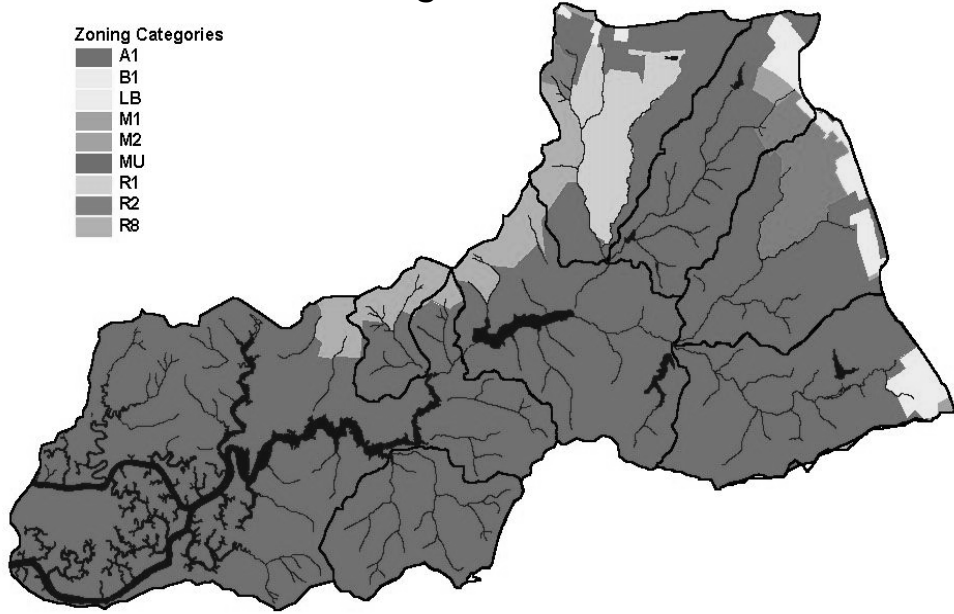
This presentation provides a simple introduction to the eight basic watershed protection tools. These tools are essential to the protection, preservation, and restoration of our lakes, streams, and estuaries. The challenge for the watershed manager is to select the right combination of practices to form the most effective plan based on the specific goals of the watershed.

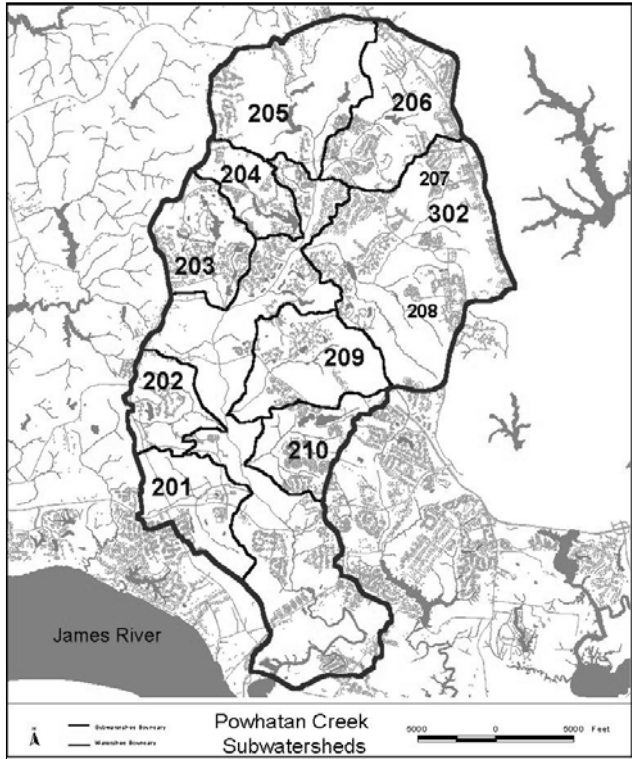
For more information on the watershed protection tools, please consult the *Rapid Watershed Planning Handbook*, 1998, available from the Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043. Visit us online at [www.cwp.org](http://www.cwp.org).

# Land Use Planning for Sensitive Streams

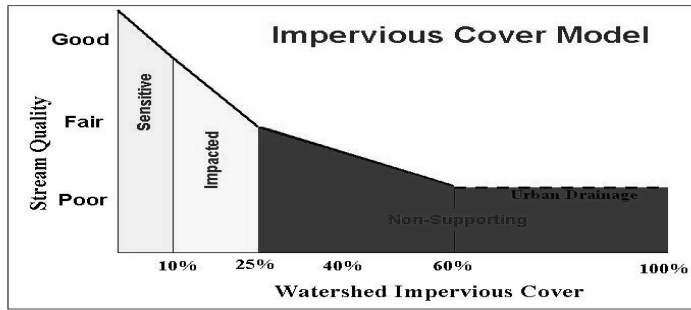
## Zoning Categories

- A1
- B1
- LB
- M1
- M2
- MU
- R1
- R2
- R8





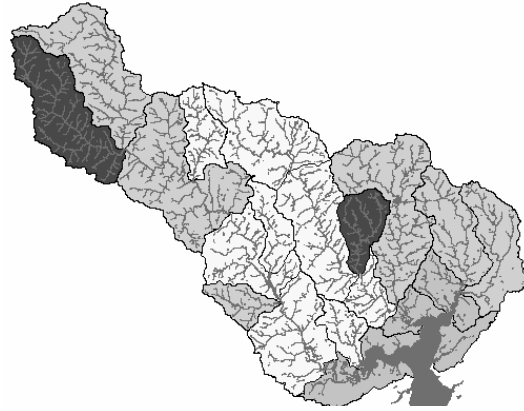
The ICM and Stream  
Classification:  
Powhatan Creek



Another Slide you'll Be getting Tired of

<u>Classification</u>	<u>1998</u>	<u>2000</u>	<u>2020</u>
Sensitive	8	6	0
Impacted	4	6	11
Non-Supporting	0	0	1

ICM used to classify and manage streams



Revised Current Management Classification

-  Sensitive
-  Rurally Impacted
-  Impacted
-  Impacted Special Resource

## Why it is so hard to integrate land use into local watershed plans?

1. Over-Zoning
2. Segregation between comprehensive and environmental planning
3. Uncertainty about the BMP effect
4. Confusion about scope of watershed plans
5. Lack of a watershed zoning unit

## Impacted Streams

10 to 25% IC

- ◆ Show clear signs of declining stream health
- ◆ Stream indicators in the fair to good range
- ◆ Stream corridor may still be intact
- ◆ Available land in subwatershed to install practices
- ◆ Streams have highest restoration potential



# Impacted streams



## Key Issue:

What practices can minimize the expected decline in stream indicators, and by how much?

1. Apply all 8 Tools of Watershed Protection
2. Set goals for retaining forest cover, riparian continuity and overall watershed treatment
3. Keep on Testing



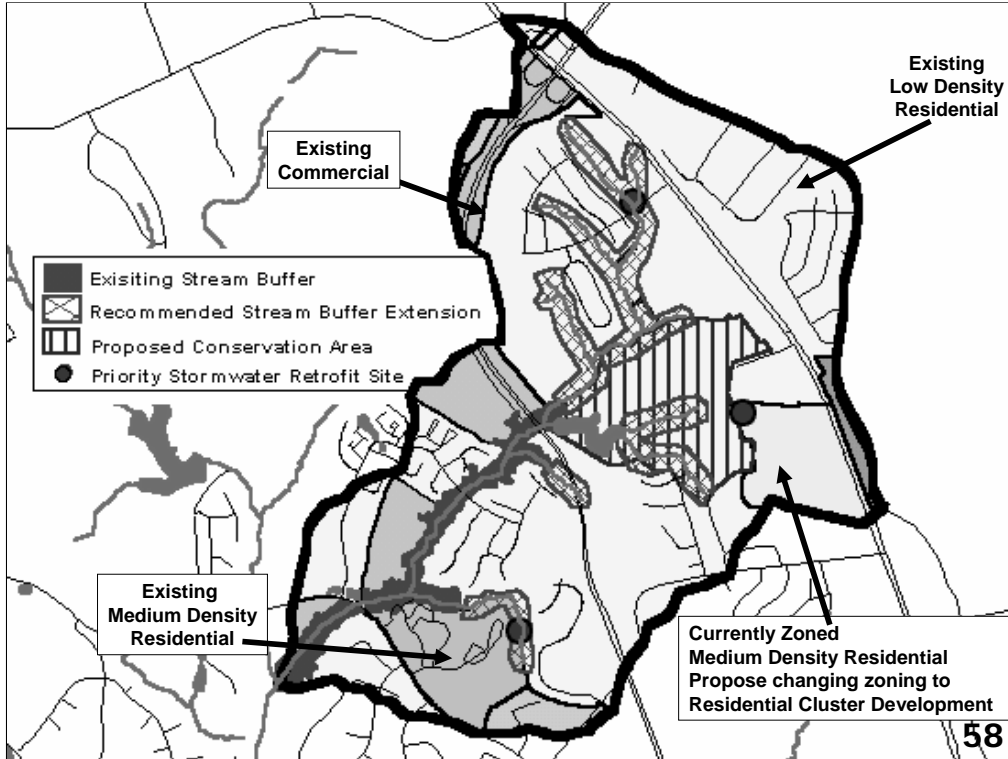
# Powhatan Creek Watershed Management Plan

**Prepared for:**  
James City County, VA

**Prepared by:**  
Paul Sturm  
Anne Kitchell  
Center for Watershed Protection  
8391 Main Street  
Ellicott City, MD 21043

July 4, 2001





## Non-Supporting Streams

25 to 60% IC

- ◆ Do not support a full range of designated uses
- ◆ Stream indicators in the fair to poor range
- ◆ Streams in 25 to 40% IC show promise for stream restoration
- ◆ Primary goals are to reduce pollutant loads, improve stream corridor or enhance appearance
- ◆ Allow water contact recreation during dry weather



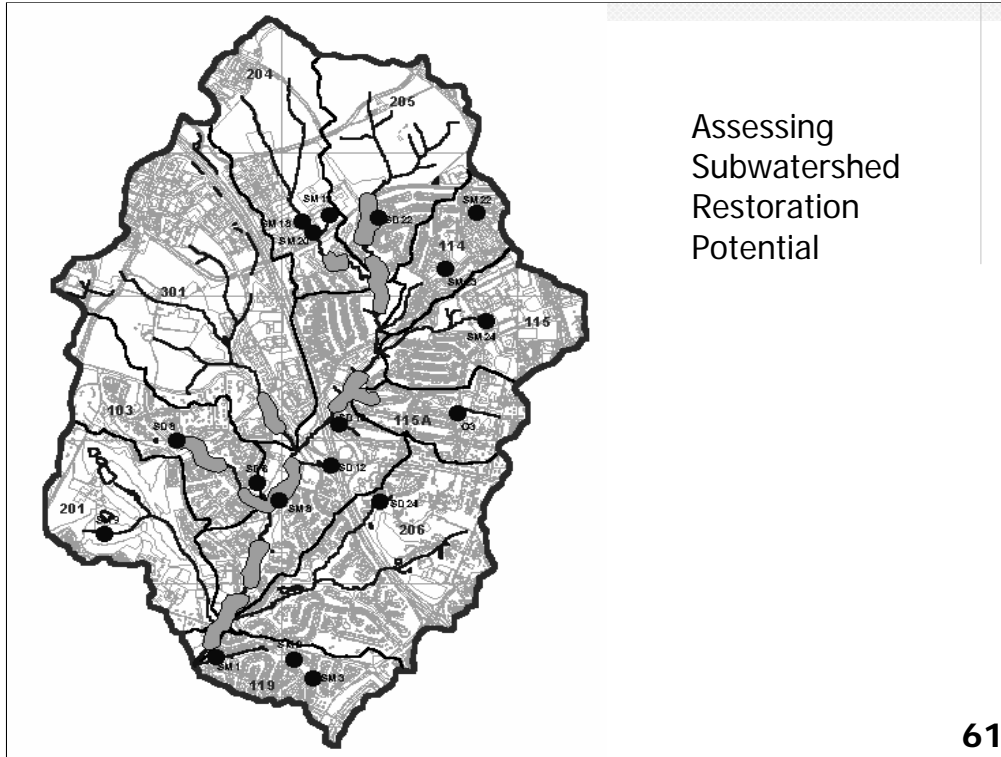
## Non-Supporting Streams



- ◆ Not likely to ever support a full range of designated uses

### Responses:

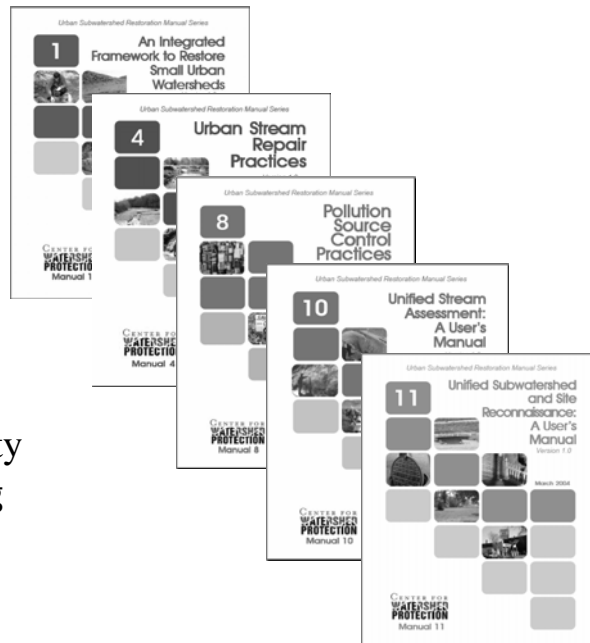
1. Evaluate streams in 25 to 40% IC for potential restoration
2. Support active redevelopment/infill to increase IC
3. Create an "urban drainage" classification for extremely high IC streams



Assessing  
Subwatershed  
Restoration  
Potential

The Small  
Watershed  
Restoration  
Manual Series

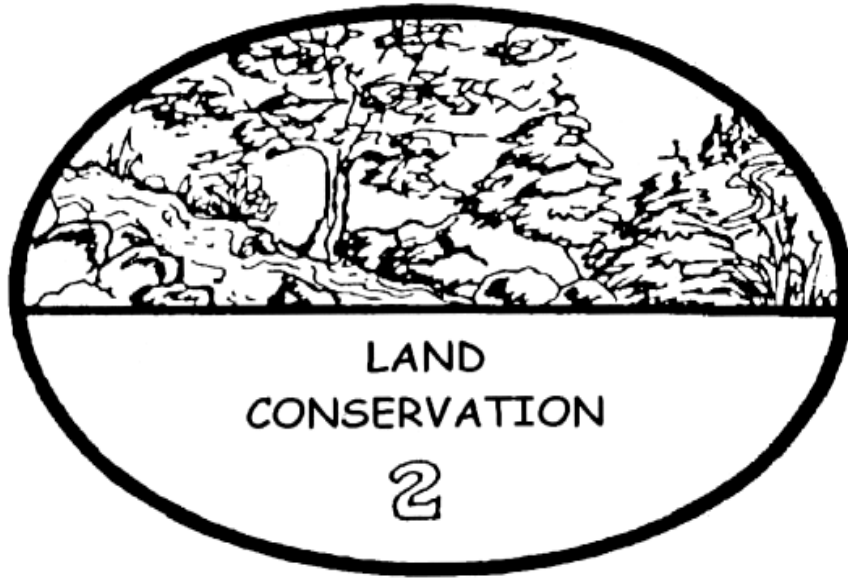
Check availability  
at [www.cwp.org](http://www.cwp.org)





Discussion Time:

How should the ICM  
be used in watershed  
planning?





# 5 Types of Conservation Areas

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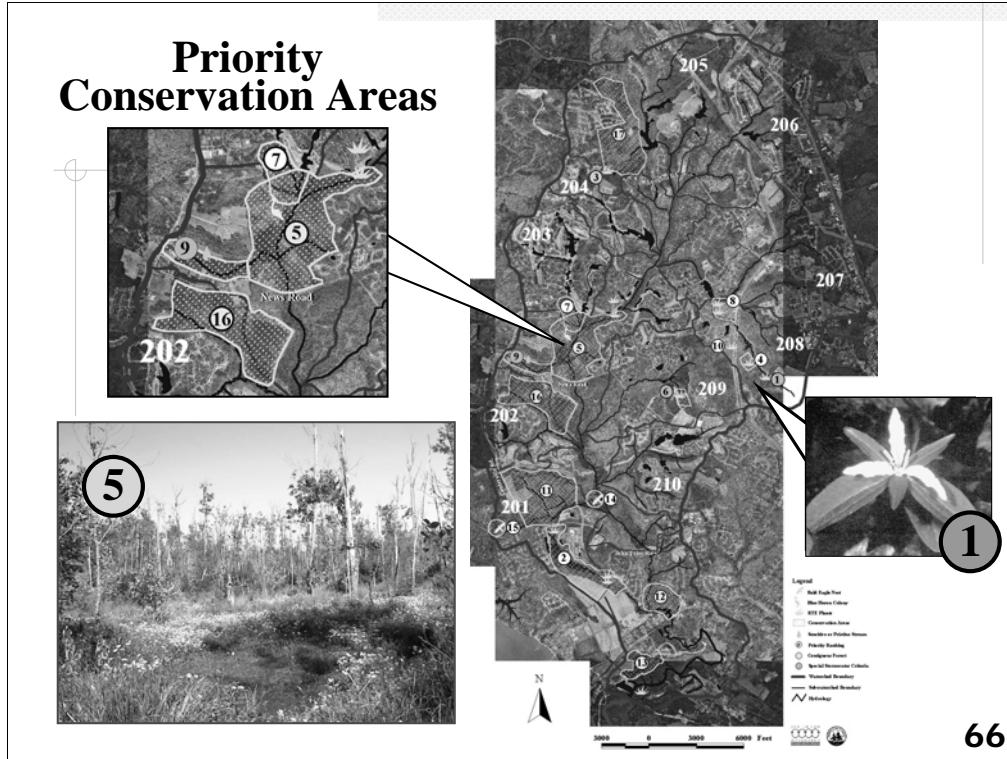
Critical Habitats

Aquatic Corridor

Cultural Areas

Hydrologic Reserve

Water Pollution Hazard



This is an example conservation areas map that prioritizes areas based on a combination of factors, such as habitat for heron rookeries, RTE plant species, contiguous forests, or riparian corridors.

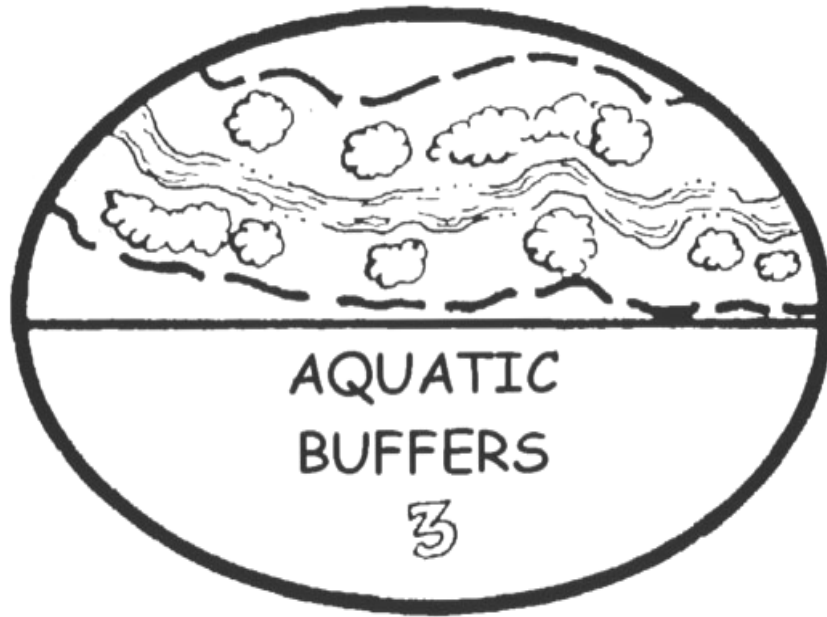
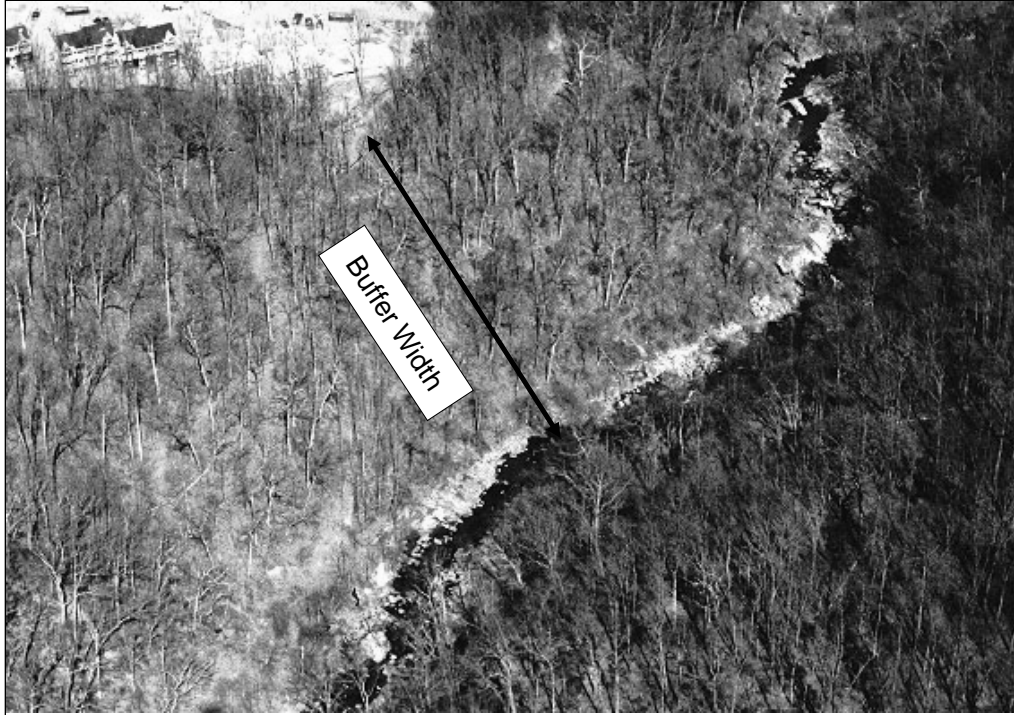
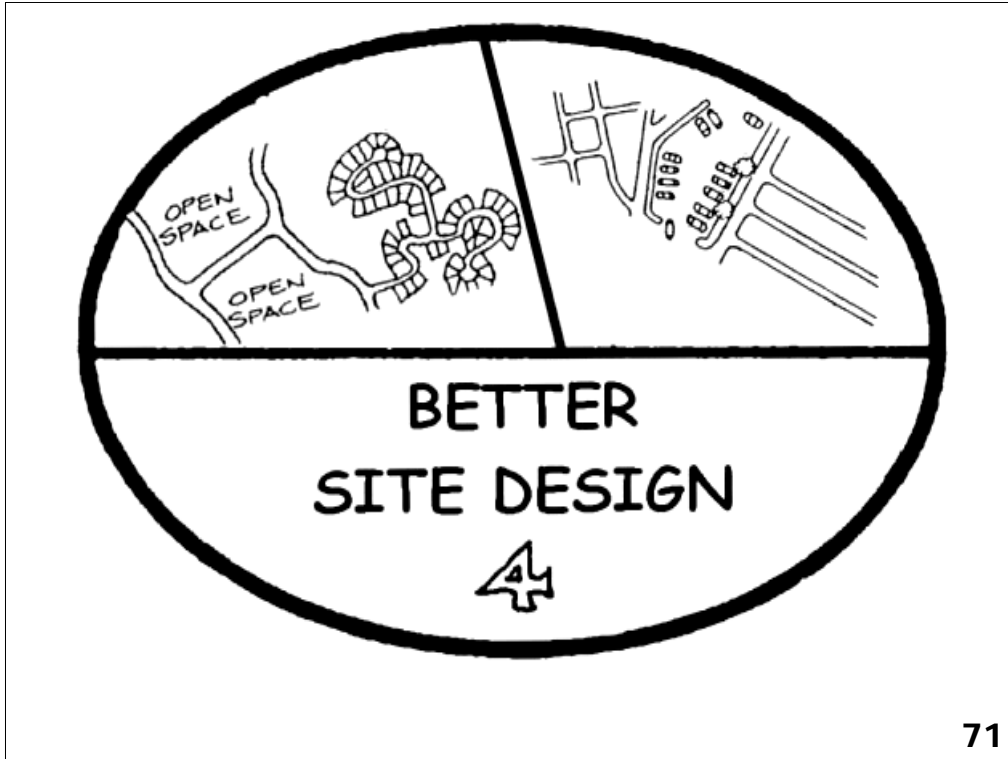




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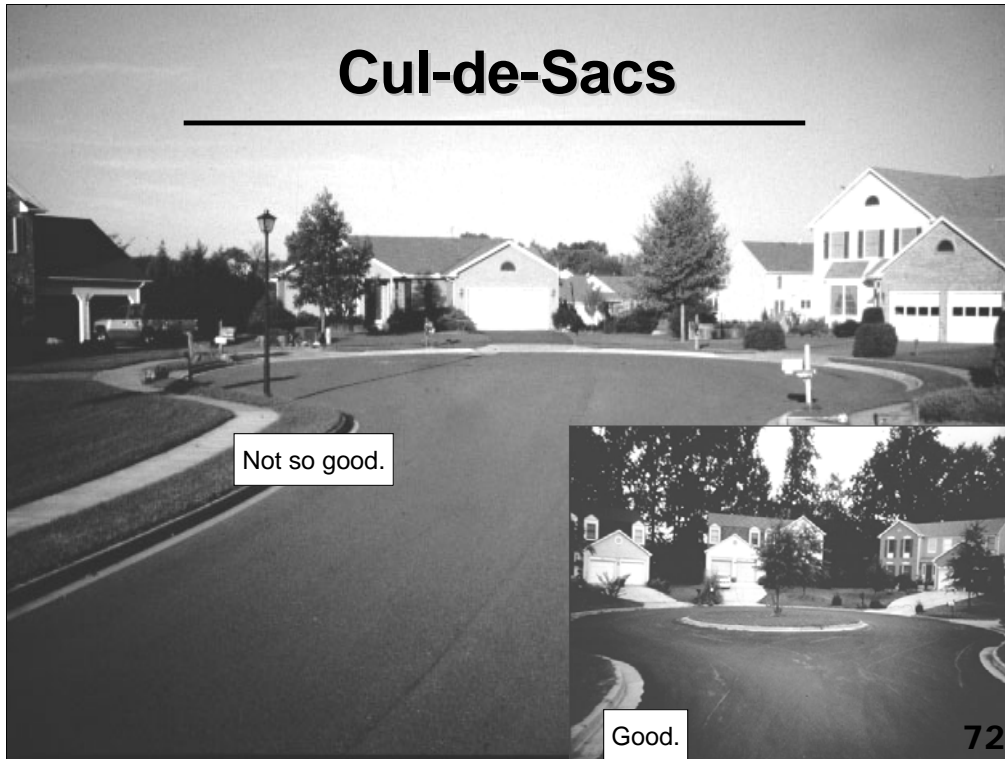






# Cul-de-Sacs

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Typical cul-de-sacs are often large enough to double as spaceship landing pads.



## Street Width



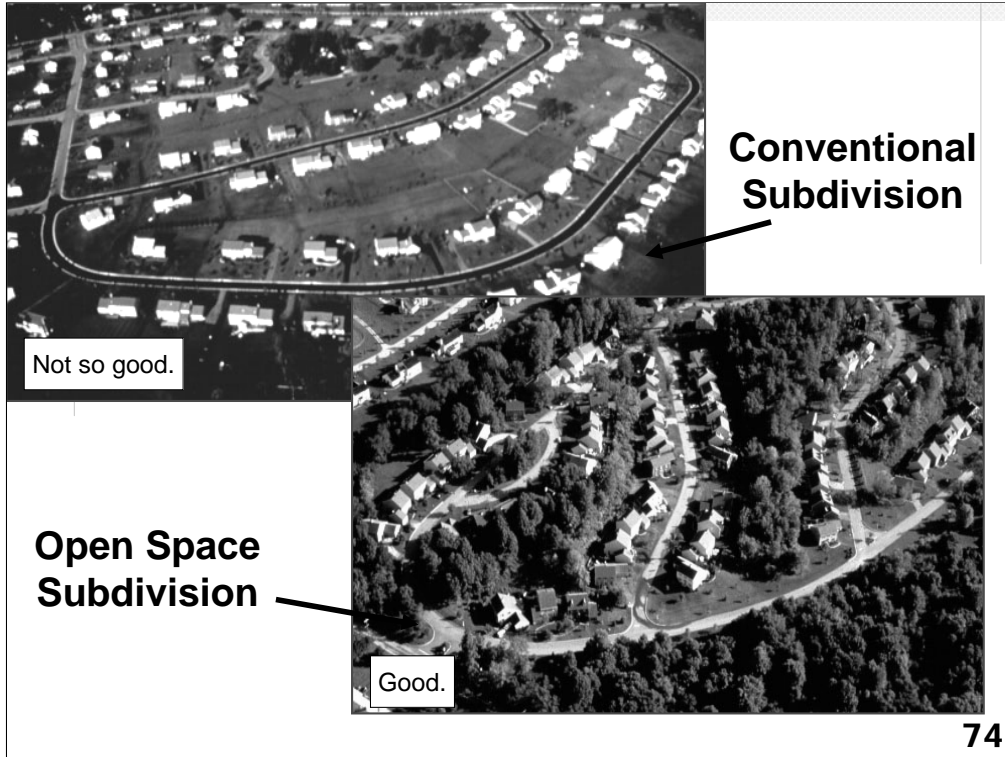
Not so good.



Good.

73

Typical streets are often excessively wide, increasing traffic speeds and making streets unfriendly to pedestrians.





Parking lots are often underutilized and can be minimized through better site design techniques. Approximately 65% of total impervious cover in the landscape is "habitat for cars," in the form of parking lots, roads, and driveways. Much of this impervious cover is often needless and can be minimized at every stage of parking lot and residential street planning and design.

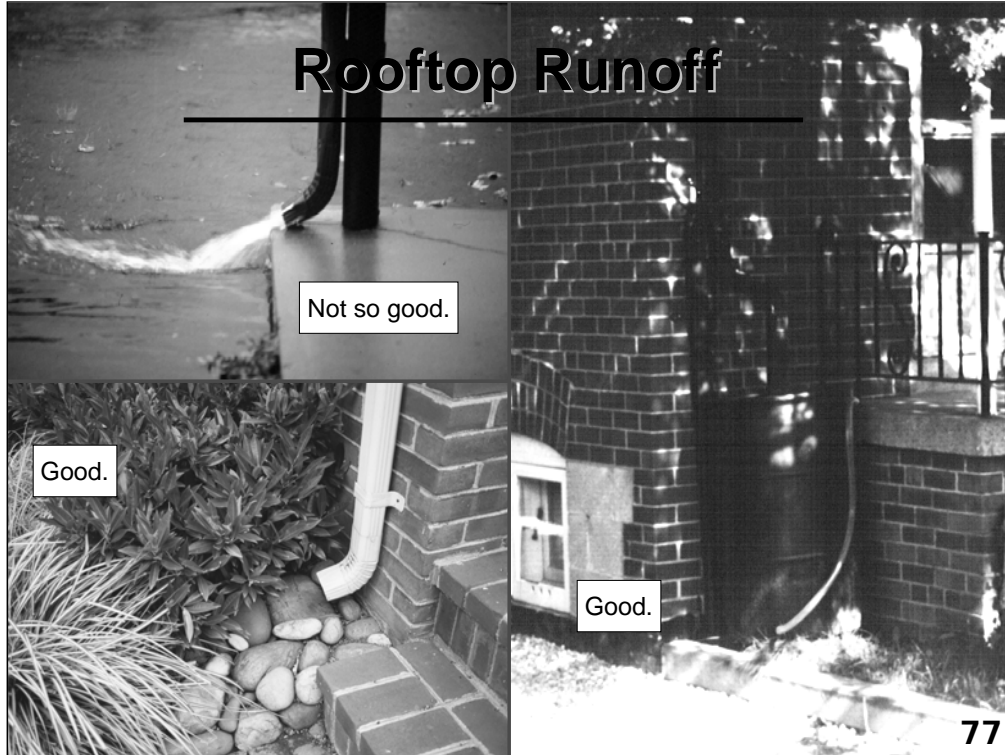
## Parking Lots



This example bioretention area is designed with trees, shrubs, and grass instead of mulch. The overflow structure in the middle of the picture allows larger storm volumes to bypass the filtration system to be conveyed directly to the drainage system.

# Rooftop Runoff

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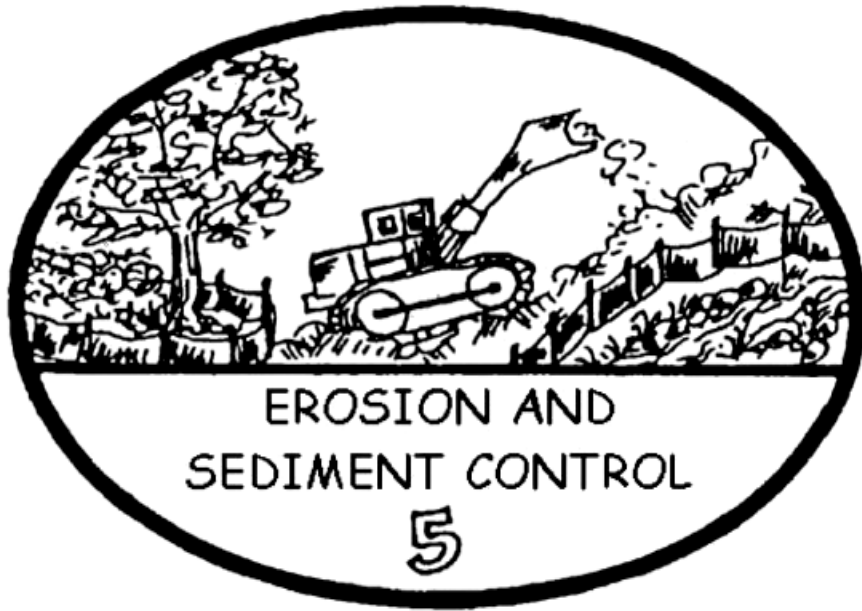


Another alternative to managing rooftop runoff is to drain the runoff directly into rain barrels, which can store the water for later use in gardens, yards, or for house plants.



Discussion Time:

How can local  
development rules be  
changed to allow for  
better site design?

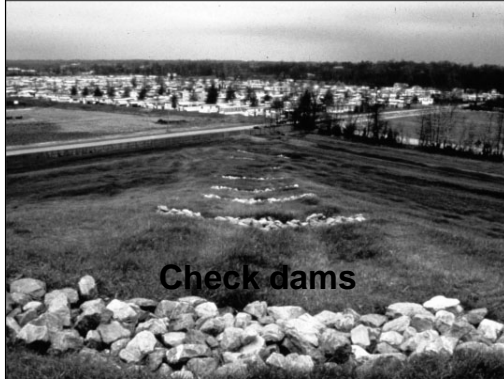




**Silt Fence**



**Hydroseeding**



**Check dams**



**Sediment Basin 80**





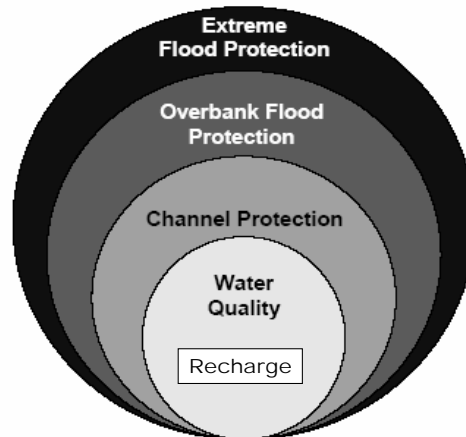
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Photo Copyright 1999, Center for Watershed Protection



## Tool 6: Stormwater Management Practices



Practices handle five different kinds of rainfall events

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Stormwater treatment practices in the watershed are often designed to achieve a specific target for phosphorus removal. Stormwater treatment can include Better Site Design techniques on residential lots and stormwater treatment practices such as ponds and wetlands for new development. For drinking water reservoirs, stormwater treatment practices should be sized and designed for maximum phosphorus removal. It is necessary to compute pre and post development phosphorus loads in order to determine how much load reduction is required. If it is not possible to meet the required reduction, a fee can be paid in lieu or stormwater practices can be used to provide phosphorus reduction elsewhere in the watershed.





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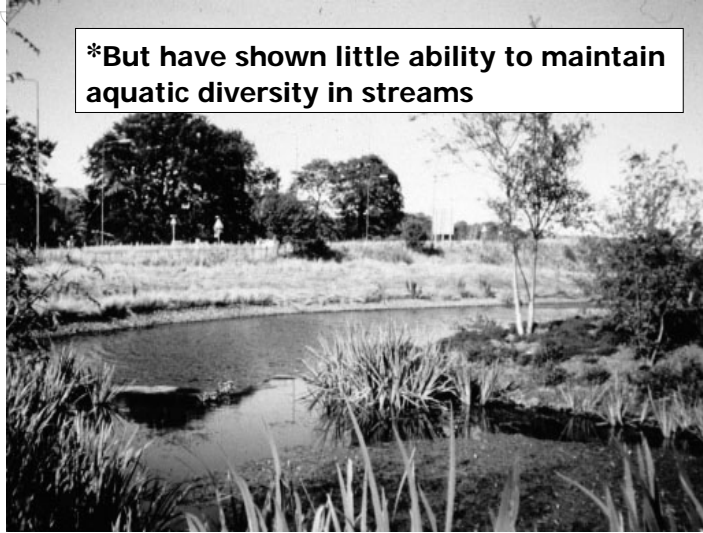






Stormwater Practices Show Moderate Ability to Remove  
Pollutants in Stormwater Runoff\*

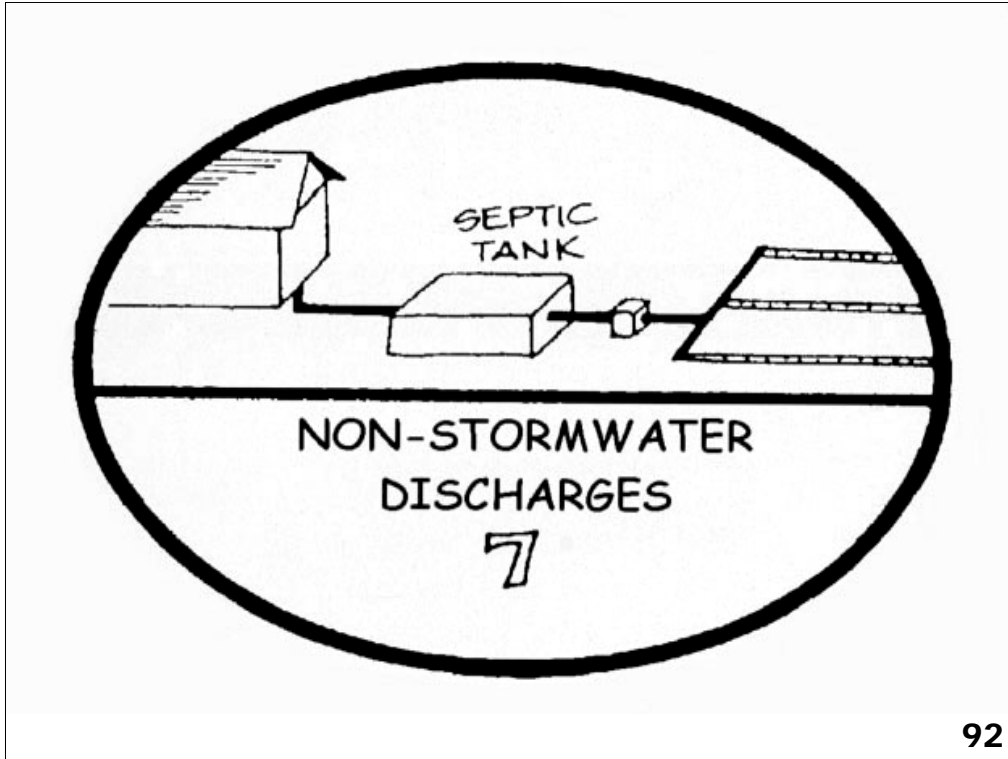
**\*But have shown little ability to maintain  
aquatic diversity in streams**





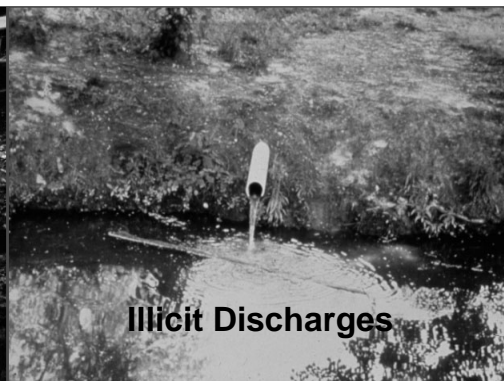
Discussion Time:

Can BMPs Offset the  
effect of Impervious  
Cover?





**Confined Animal Facilities**



**Illicit Discharges**

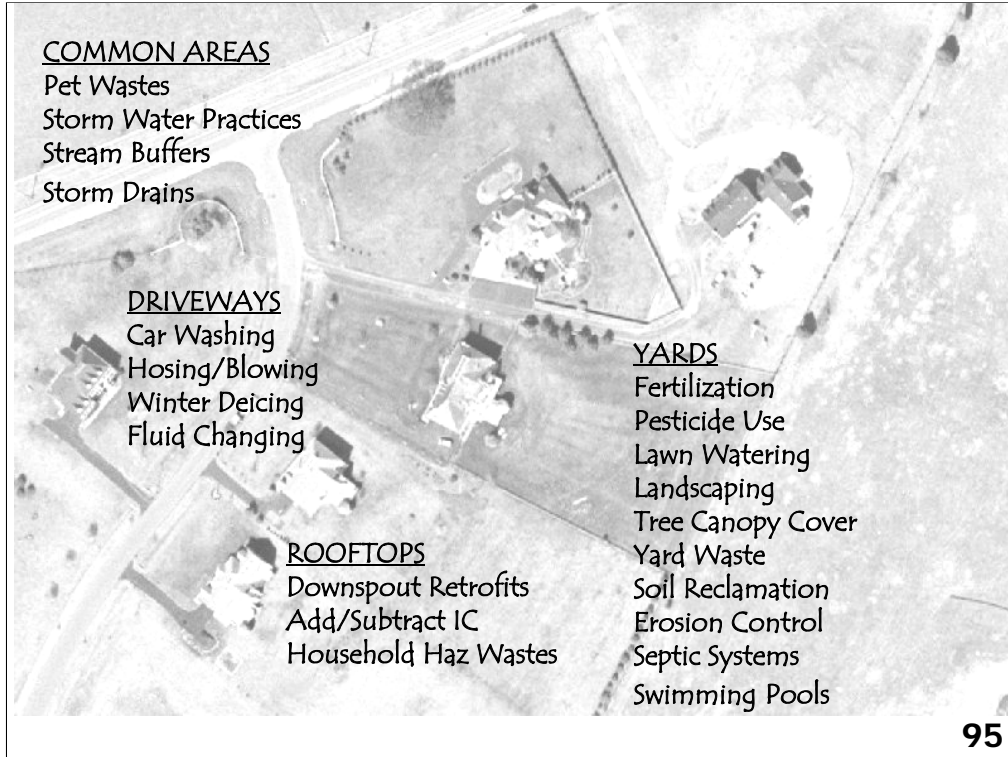


**Failing Septic Systems**



**Sanitary Sewer Overflows**





COMMON AREAS

- Pet Wastes
- Storm Water Practices
- Stream Buffers
- Storm Drains

DRIVEWAYS

- Car Washing
- Hosing/Blowing
- Winter Deicing
- Fluid Changing

ROOFTOPS

- Downspout Retrofits
- Add/Subtract IC
- Household Haz Wastes

YARDS

- Fertilization
- Pesticide Use
- Lawn Watering
- Landscaping
- Tree Canopy Cover
- Yard Waste
- Soil Reclamation
- Erosion Control
- Septic Systems
- Swimming Pools



What are some key differences between two neighborhoods that may influence pollutant generation?



## Question 1

What is the largest crop by area in most metropolitan areas?



## Answer:

- ◆ Turfgrass is single largest crop by area in the Chesapeake Bay Basin
- ◆ Grows by 5 to 10% each decade
- ◆ 2/3 is the home lawn
- ◆ Nutrients, pesticides, and irrigation

## Question 2

What proportion of homeowners apply fertilizer?

How many over-fertilize?



## Answer:

- ◆ Almost 90% of residents have a yard
- ◆ About 50% fertilize their yard
- ◆ Average of two applications per year
- ◆ 50% of fertilizers over-fertilize

Question 3

How many households own a dog?

What percentage of dog-walkers pick up after their pets?



## Answer:

- ◆ About 40% of all households own a dog
- ◆ Only half of dog owners are dog walkers
- ◆ About 60% of dog-walkers claim to pick up after their dog "some or all of the time"
- ◆ What a bunch of liars

Question 5

What percentage of homeowners wash their own cars?

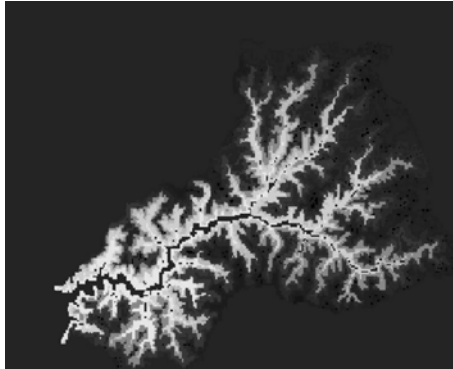
How frequently do they do it?



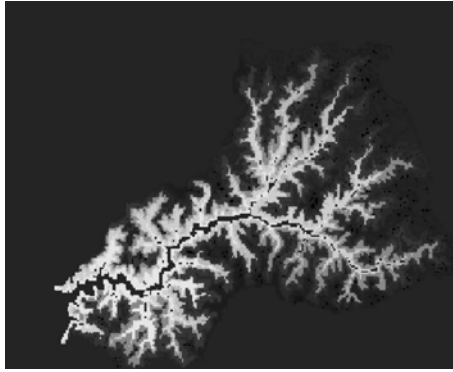
## Answer:

- ◆ 60 to 70% of households wash their own cars
- ◆ 60% of these can be considered chronic car washers (wash at least once a month)
- ◆ 80% reported wash water drained directly to the street (and presumably the storm drain)
- ◆ ~ 800 gallons per hour with hose





Discussion Time:  
How can we design  
more effective  
campaigns to change  
watershed behaviors?



Discussion Time:

Final Thoughts

# Thank You

After viewing the links to additional resources, please complete our online feedback form.

**Thank You**

[Links to Additional Resources](#)