Stormwater 101
An Introduction for Master Gardeners

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Biological Systems Engineering
Virginia Tech
What is a watershed?

- The land area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ultimately the ocean.

Source: Left – EPA; Right – Biological Systems Engineering, Virginia Tech
Conceptual Watershed

Point Source Pollution

- Any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are or may be discharged.

(Clean Water Act 1987)
Nonpoint Source Pollution

- Nonpoint Source Pollution (NPS): Essentially any diffuse pollution sources that are not defined by law as point sources.
- Usually contributes pollutant loads during precipitation events, affecting streams during periods of high flow.
Examples of NPS Pollutants

**Sediment**
Soil particles transported from their source

**Biochemical Oxygen Demand (BOD)**
- Oxygen depleting material
  - Leaves
  - Organic material

**Toxics**
- Pesticides
  - Herbicides
  - Fungicides
  - Insecticides
- Metals (naturally occurring in soil, automotive emissions/tires)
  - Lead
  - Zinc
  - Mercury
- Petroleum Hydrocarbons (automotive exhaust and fuel/oil)

**Nutrients**
- Various types of materials that become dissolved and suspended in water (commonly found in fertilizer and plant material):
  - Nitrogen (N)
  - Phosphorus (P)

**Debris**
Litter and illegal dumping

**Bacteria/ Pathogens**
Originating from:
- Pets
- Waterfowl
- Failing septic systems

**Thermal Stress**
Heated runoff, removal of streamside vegetation

Source: Rutgers University
Why is NPS pollution important?

- Sediment reduces light penetration in stream, impacts habitat, clogs gills, reduces impoundment capacity
- Nutrients act as fertilizer for algae & aquatic plants which can cause highly varying dissolved oxygen levels. Low dissolved oxygen levels harmful to aquatic life
- BOD depletes dissolved oxygen.
- Toxics can impact life cycles and contaminate drinking water supplies.
- Bacteria/pathogens are indicators of fecal contamination

Source: Rutgers University
Additional “pollutant”

- Impervious Cover

- roads, rooftops, parking lots, and other hard surfaces that do not allow stormwater to soak into the ground

- provides a surface for accumulation of pollutants

- leads to increased polluted runoff and flooding

- inhibits groundwater recharge

Sources: Rutgers University; Biological Systems Engineering, Virginia Tech
Effect of Development on Stormwater

Source: Stream Corridor Restoration, 1998
Consequences of Urbanization

- More surface runoff
- Faster surface runoff
- Higher stream flow during storms
- Higher velocities, more energy
- Less infiltration
- Less groundwater recharge
- Lower stream flows during dry periods

Adapted from Cully Hession, Virginia Tech
BSE5404: Urban Impacts on Water Resources
VA state-wide Stormwater Regulations

- House Bill 1177 (01/05) transferred stormwater oversight from DEQ to DCR.

- Stormwater program seeks to
  - protect properties and aquatic resources from damages caused by increased volume, frequency and peak rate of stormwater runoff, and
  - protect aquatic resources from increased nonpoint source pollution carried by stormwater runoff

- Phosphorous key pollutant
  - phosphorous load limit not to exceed 0.28lbs/acre/year

- Aim is local enforcement. If localities can’t/choose not to administer program, state takes responsibility

- Stormwater Management Handbook and design protocols being revised
Regulated/Nonregulated Activities

- Residential, commercial, industrial or institutional land development and conversion activities that involve land-clearing or soil movement (typically any disturbance > 1 acre)

- Tilling, planting or harvesting of agricultural, horticultural, or forest crops;

- Single-family residences or modifications to existing residences not part of a subdivision;

- Land development projects that disturb less than one acre, unless lowered by the locality; and

- Linear development projects
Proposed New Stormwater Strategy

Criteria:
- 0.28 lb/acre/year P loading from site through ESD, RR, PR
- Equivalent to forested conditions
- Redevelopment set at 20% improvement

Source: Technical Memorandum: The Runoff Reduction Method, April 18, 2008, Center for Watershed Protection
## Table 1. Practices Included in the Runoff Reduction Method

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<td>Filtering Practice</td>
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<td>Rooftop Disconnection:</td>
<td>Constructed Wetland</td>
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<td>Site Design to Minimize Impervious Cover &amp; Soil Disturbance</td>
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Practices in shaded cells achieve both Runoff Reduction (RR) and Pollutant Removal (PR) functions, and can be used for Steps 2 and 3 depicted in Figure 1. See Appendices B and C for documentation.

Source: Technical Memorandum: The Runoff Reduction Method, April 18, 2008, Center for Watershed Protection
Meeting Goals with Environmental Site Design (ESD)

- Forest conservation
- Soil restoration
- Minimize Impervious cover
- Conservation Subdivisions

Meeting Goals with Runoff Reduction (RR)

- Sheetflow to open space
- Rooftop Disconnects
- Green Roofs
- Porous Pavement
- Bioretention
- Dry Swales
- Infiltration
- Wet Swales
- Extended Detention

Meeting Goals with Pollutant Removal (PR)

- Filtering Practices
- Constructed Wetland
- Wet Swale
- Wet Pond
- Alum or other chemical treatment
- Other proprietary technologies

Sources: [www.bae.ncsu.edu/stormwater](http://www.bae.ncsu.edu/stormwater); WSSI/Wetland Studies and Solutions, Inc., at [http://www.wetlandstudies.com](http://www.wetlandstudies.com); Prince Georges County, MD Adapted from David J. Hirschman City of Winchester – Watershed Management Workshop April 27, 2005
Conventional Site Design

The “Good Drainage” Paradigm

Source: Prince Georges County, MD
Adapted from David J. Hirschman, City of Winchester – Watershed Management Workshop, April 27, 2005
Collect, Convey, Concentrate, Centralized Treatment

Source: Prince Georges County, MD
Adapted from David J. Hirschman, City of Winchester – Watershed Management Workshop, April 27, 2005
Distributed, Disconnected, Decentralized

Source: Prince Georges County, MD
Adapted from David J. Hirschman, City of Winchester – Watershed Management Workshop, April 27, 2005
Conventional

Low Impact

Good Drainage

Functional Landscape Design

Source: Prince Georges County, MD
Adapted from David J. Hirschman, City of Winchester – Watershed Management Workshop, April 27, 2005
Rain Garden

Source: Prince Georges County, MD
Adapted from David J. Hirschman
City of Winchester – Watershed Management Workshop
April 27, 2005