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The Runoff Reduction Method

Experiences from Washington, D.C., and Neighbouring States

Gregory Hoffmann, P.E.
Center for Watershed Protection

CENTER FOR WATERSHED PROTECTION

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
- 24 staff in MD, VA, PA, NY

www.cwp.org

CENTER FOR WATERSHED PROTECTION

CENTER FOR WATERSHED PROTECTION ASSOCIATION

a program of the Center for Watershed Protection, Inc.

An opportunity to support sound watershed management and connect with other practitioners.

Member Benefits

Substantial Webcast Discounts

Free "Lunch and Learns"

Access to Watershed Science Bulletin

LinkedIn Discussion Group

Access to our Runoff Ramblings blog

Access to OWL (Online Watershed Library)

www.cwp.org

Who are You?

Are you from…

-a watershed group?

-a consulting firm?

-a local government?

-a provincial or national agency?

-a university?

-somewhere I’ve forgotten to mention?

Who are You?

-How many of you have taken a photograph of a stormwater practice while you are on vacation?

Definitions of Stormwater Management

1. Get rid of it!

Definitions of Stormwater Management

2. Hold on to it – for a little while.

Definitions of Stormwater Management

3. Hold on to it indefinitely, remove the pollutants, but don't create flooding problems or let it be a nuisance.

???

If we can use all of these…

why do we always get these?

What are the top 6 reasons that LID stormwater practices are not implemented on development projects?

1

2

3

4

5

6

We've been asking for it!

We encourage large volume detention facilities with our Post-Construction Stormwater Ordinances and Criteria:

- Flood Control
- Channel Protection
- Water Quality

What are we asking for?

- Conventional Stormwater Management Criteria
  - Flood Control
    - Detention for 10, 25, 100 year storm events
  - Channel Protection
    - Detention of 1- or 2-year, 24-hour storm
  - Water Quality
    - Capture and treat “first flush” (usually 0.5” (1.3 cm) of runoff)

Ponds are prevalent because their compliance with our existing stormwater criteria can be readily verified

Runoff Reduction Method Technical Memorandum

April, 2008

Chesapeake Stormwater Network

Center for Watershed Protection

The Runoff Reduction Method

- Shift focus from Flood Control and Pollutant Removal to **Runoff Reduction**

- Runoff Reduction
  - Reduces runoff volume
  - Reduces pollutant loads
  - Mimics pre-development hydrology
  - Groundwater recharge
  - Reduce the size of large storage BMPs

Stormwater Practices Differ Sharply in Ability to Reduce Runoff Volume

Ponds, Wetlands, and Filters Reduce Runoff Volumes by 0 to 10%

Bioretention, Infiltration, Dry Swales and Related Practices Reduce Runoff Volumes by 50 to 90%

Bioretention Research

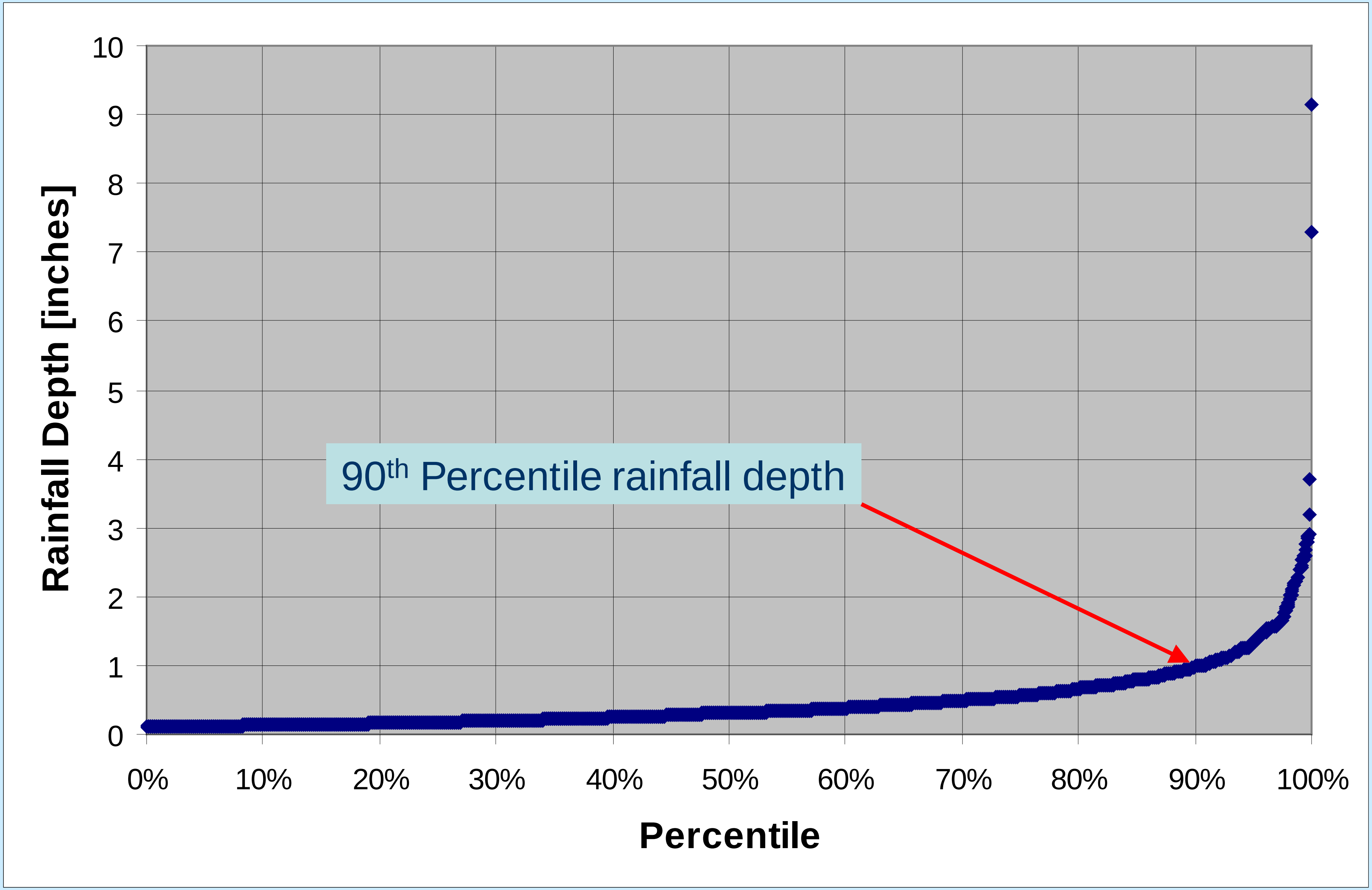
Table B-6. Volumetric Runoff Reduction Achieved by Bioretention			
LID Practice	**Location**	**% Runoff Reduction**	Reference
Bioretention *	CT	99%	Dietz and Clausen (2006)
Bioretention *	PA	86%	Ermilio (2005)
Bioretention *	FL	98%	Rushton (2002)
Bioretention *	AUS	73%	Lloyd et al (2002)
Bioretention #	ONT	40%	Van Seters et al (2006)
Bioretention #	Model	30%	Perez-Perdini et al (2005)
Bioretention #	NC	40 to 60%	Smith and Hunt (2007)
Bioretention #	NC	20 to 29%	Sharkey (2006)
Bioretention #	NC	52 to 56%	Hunt et al. (2006)
Bioretention #	NC	20 to 50%	Passeport et al. (2008)
Bioretention #	MD	52 to 65%	Davis (2008)
Runoff Reduction Estimate		40# to 80*	
*infiltration design; # underdrain design			

Runoff Reduction Processes

Runoff Reduction is not just infiltration!

- ✓ Infiltration
- ✓ Canopy Interception
- ✓ Evaporation
- ✓ Transpiration
- ✓ Rainwater Harvesting
- ✓ Extended Filtration

90^{th} Percentile rainfall depth = 1” (2.5 cm)



First: Reduce Stormwater Runoff By Design

- Better site planning & design techniques
  - Preserve natural areas
  - Conservation design
  - Reduce clearing & grading limits
  - Reduce roadway widths
  - Eliminate excessive impervious cover
  - And more…




Second: Reduce Volume of Post-Construction Stormwater Runoff

- Small-scale, distributed practices
  - Soil Restoration
  - Downspout Disconnection
  - Rain Gardens/Small Bioretention Areas
  - Rainwater Harvesting
  - Permeable Pavement
  - Green Roofs
  - Natural Drainage Ways
  - Vegetated Channels
  - Site Reforestation
  - Buffers

Third: Capture & Treat Remaining Stormwater Runoff

- Larger-scale, engineered practices
  - ponds
  - wetlands

Next: Iterate or Mitigate

- When any stormwater criteria cannot be met on site:
  - Back to Step 1 (Iterative site design process)
  - Mitigate Unmanaged Impacts
    - Off-site mitigation
    - Payment in lieu

Runoff Reduction (RR) Method Details

- Codify avoidance and minimization;
- Go beyond impervious cover as the sole water quality indicator;
- Credit practice performance;
- Account for practices in series
- Apply runoff reduction practices to larger design storms.

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Managed Turf

- Documented impacts of grading and compaction of soils:
  - Increased bulk density
  - Decreased permeability
  - Increased runoff coefficient

- Documented impacts from turf management activities:
  - Fertilization;
  - Pest management;

Water Quality Implications

Simple Method:

$$WQv = P/12 * R_v * A$$

where:

WQv	= water quality volume (ac-ft)
P	= precipitation (1 inch)
R_v	= volumetric runoff coefficient
	= (0.05 + 0.009*I)
A	= drainage area (acres)
12	= unit conversions

Treatment Volume: Site Runoff Coefficients (Rv)[1]

Cover	HSG A	HSG B	HSG C	HSG D
Forest	0.00*	0.00*	0.00*	0.00*
Managed Turf / Disturbed Soil	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

[1] Center for Watershed Protection – Technical Memorandum: The Runoff Reduction Method; 4/18/08

*Forest coefficient adjusted for assessing compliance

Pitt et al (2005), Lichter and Lindsey (1994), Schueler (2001a, 2001b, 1987), Legg et al (1996), Pitt et al (1999), and Cappiella et al (2005)

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Practices in Series

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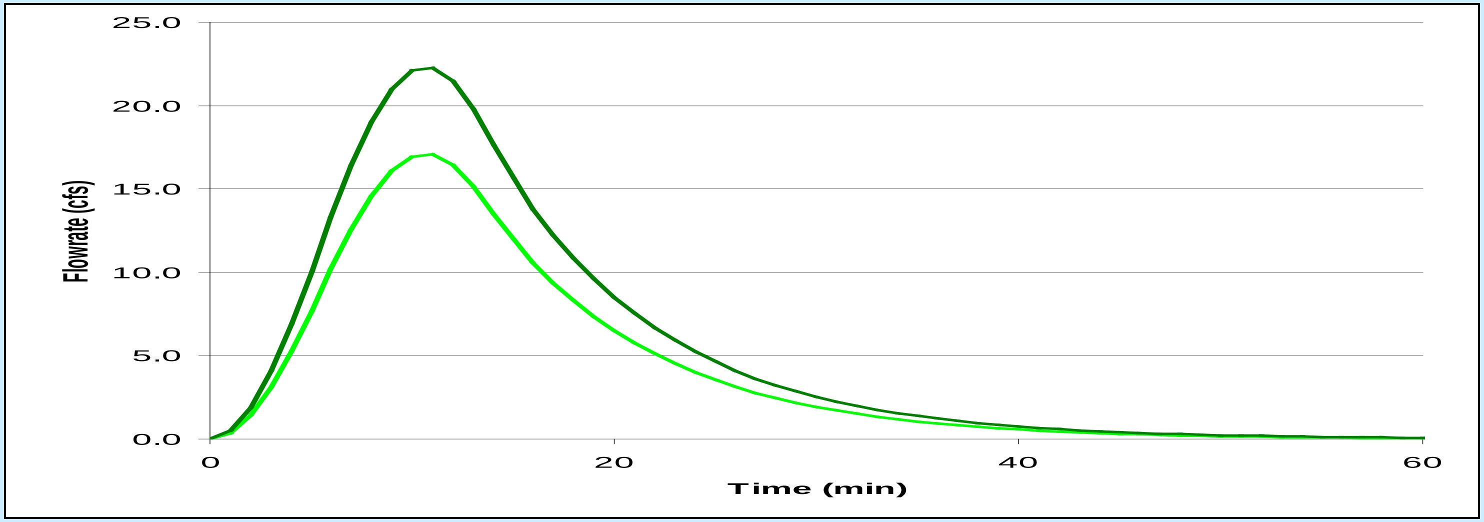
Curve Number Reduction

1. Calculate Curve Number and Site Runoff Volume
2. Subtract Runoff Reduction Volume Achieved from Site Runoff Volume
3. Determine Reduced Curve Number based on Reduced Site Runoff Volume



Example:
Washington, D.C.

- Retention Standard of 1.2” (3 cm) of rainfall.
- No breaks for redevelopment.
- Created Stormwater Retention Credit program, a publicly tradable market for stormwater volume.

Other Examples:

- Virginia: 1” (2.5 cm)
  - added phosphorus removal to the compliance calculations.

- Coastal Georgia and Coastal South Carolina: 1”
  - Added coastal-specific concerns to their runoff reduction manual.

- West Virginia: 1” (2.5 cm)
  - Went from no stormwater rules straight to runoff reduction program