

# STATE OF THE KNOWLEDGE: STORMWATER PONDS IN THE COASTAL ZONE

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# SC Stormwater Ponds

Over 8000 ponds in coastal zone

Ponds provide

- Flood control
- Sediment capture



Rick Dove, Neuse Riverkeepers



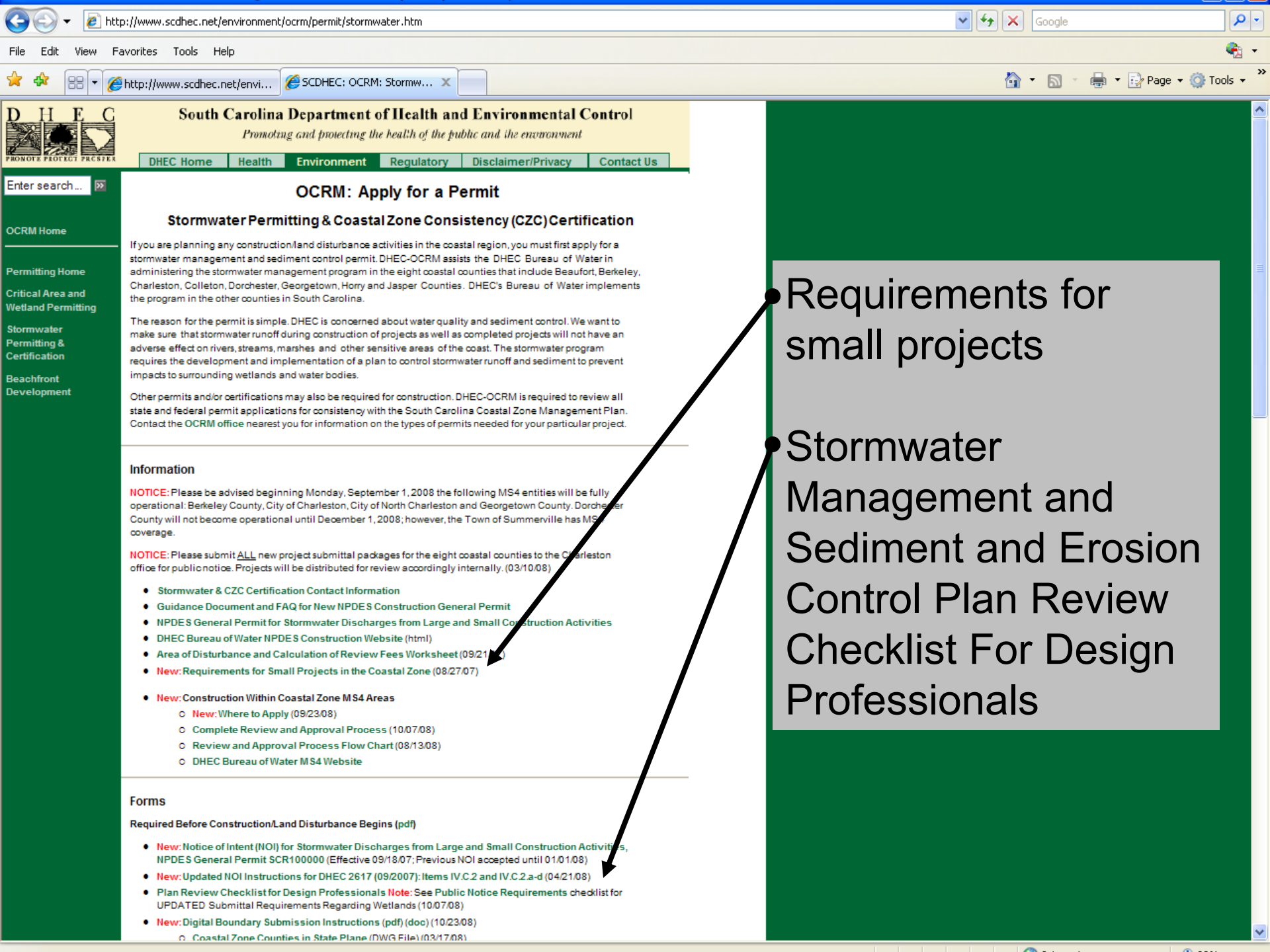
# Stormwater Permit Required if...

- Disturb  $\geq 1$  acre(s) and not within  $\frac{1}{2}$  mile receiving water

**OR**

- Disturb  $> \frac{1}{2}$  acre and within  $\frac{1}{2}$  mile of receiving water





## South Carolina Department of Health and Environmental Control

Promoting and protecting the health of the public and the environment

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### OCRM: Apply for a Permit

#### Stormwater Permitting & Coastal Zone Consistency (CZC) Certification

If you are planning any construction/land disturbance activities in the coastal region, you must first apply for a stormwater management and sediment control permit. DHEC-OCRM assists the DHEC Bureau of Water in administering the stormwater management program in the eight coastal counties that include Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry and Jasper Counties. DHEC's Bureau of Water implements the program in the other counties in South Carolina.

The reason for the permit is simple. DHEC is concerned about water quality and sediment control. We want to make sure that stormwater runoff during construction of projects as well as completed projects will not have an adverse effect on rivers, streams, marshes and other sensitive areas of the coast. The stormwater program requires the development and implementation of a plan to control stormwater runoff and sediment to prevent impacts to surrounding wetlands and water bodies.

Other permits and/or certifications may also be required for construction. DHEC-OCRM is required to review all state and federal permit applications for consistency with the South Carolina Coastal Zone Management Plan. Contact the OCRM office nearest you for information on the types of permits needed for your particular project.

#### Information

**NOTICE:** Please be advised beginning Monday, September 1, 2008 the following MS4 entities will be fully operational: Berkeley County, City of Charleston, City of North Charleston and Georgetown County. Dorchester County will not become operational until December 1, 2008; however, the Town of Summerville has MS4 coverage.

**NOTICE:** Please submit ALL new project submittal packages for the eight coastal counties to the Charleston office for public notice. Projects will be distributed for review accordingly internally. (03/10/08)

- [Stormwater & CZC Certification Contact Information](#)
- [Guidance Document and FAQ for New NPDES Construction General Permit](#)
- [NPDES General Permit for Stormwater Discharges from Large and Small Construction Activities](#)
- [DHEC Bureau of Water NPDES Construction Website \(html\)](#)
- [Area of Disturbance and Calculation of Review Fees Worksheet \(09/21/07\)](#)
- [New: Requirements for Small Projects in the Coastal Zone \(08/27/07\)](#)
  
- **New:** [Construction Within Coastal Zone MS4 Areas](#)
  - [New: Where to Apply \(09/23/08\)](#)
  - [Complete Review and Approval Process \(10/07/08\)](#)
  - [Review and Approval Process Flow Chart \(08/13/08\)](#)
  - [DHEC Bureau of Water MS4 Website](#)

#### Forms

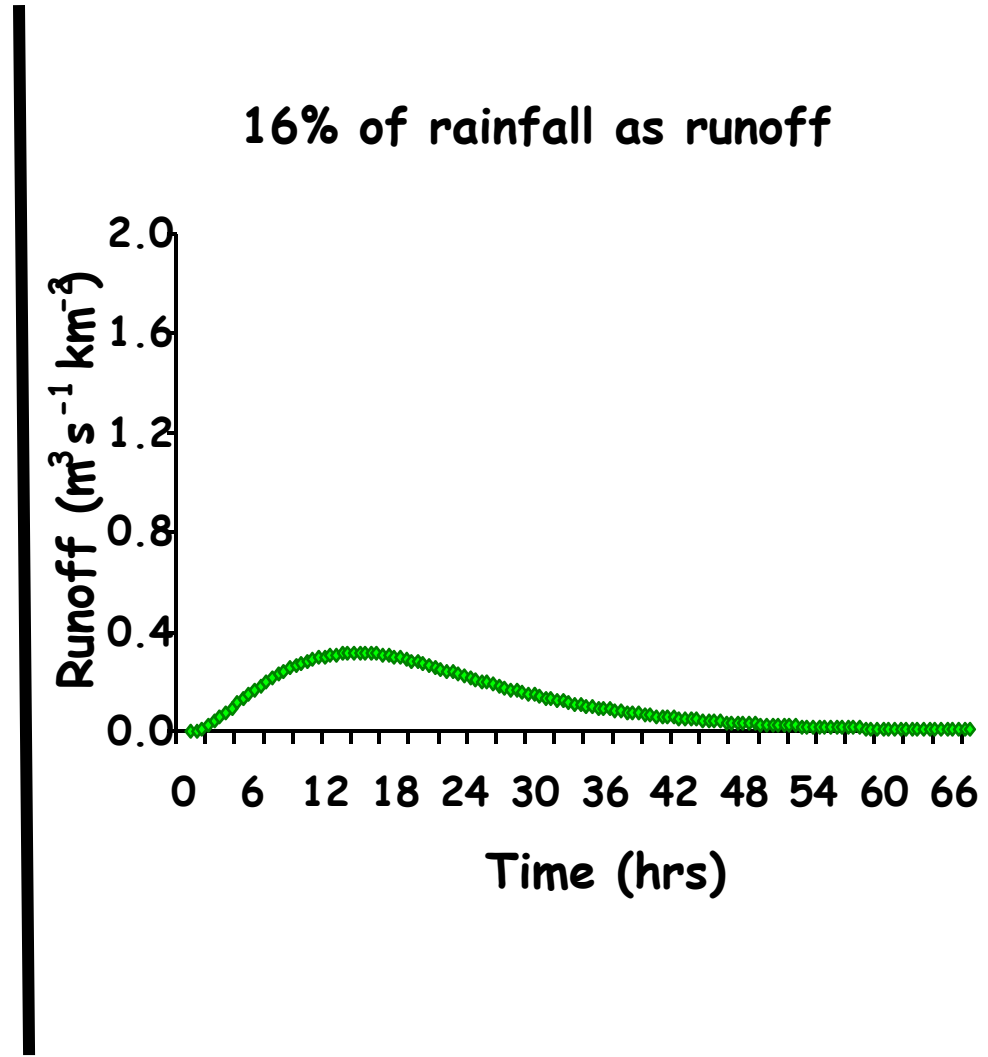
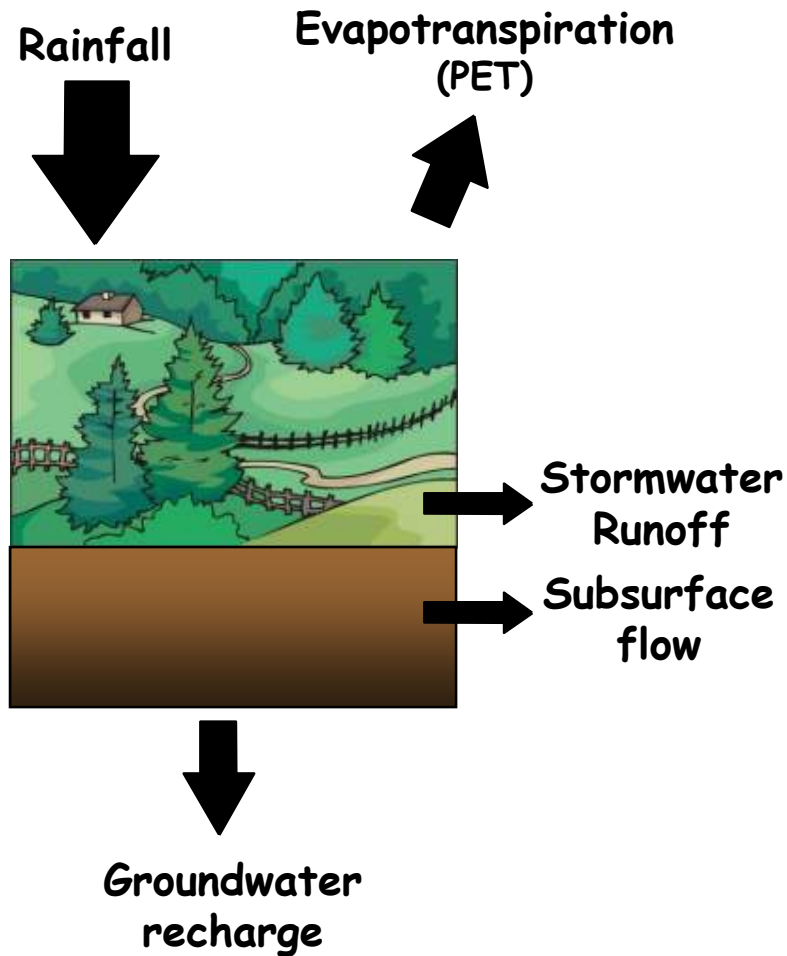
##### Required Before Construction/Land Disturbance Begins (pdf)

- **New:** [Notice of Intent \(NOI\) for Stormwater Discharges from Large and Small Construction Activities, NPDES General Permit SCR100000 \(Effective 09/18/07; Previous NOI accepted until 01/01/08\)](#)
- **New:** [Updated NOI Instructions for DHEC 2617 \(09/2007\): Items IV.C.2 and IV.C.2 a-d \(04/21/08\)](#)
- [Plan Review Checklist for Design Professionals](#) **Note:** See [Public Notice Requirements checklist for UPDATED Submittal Requirements Regarding Wetlands \(10/07/08\)](#)
- **New:** [Digital Boundary Submission Instructions \(pdf\) \(doc\) \(10/23/08\)](#)
  - [Coastal Zone Counties in State Plane \(DWG File\) \(03/17/08\)](#)

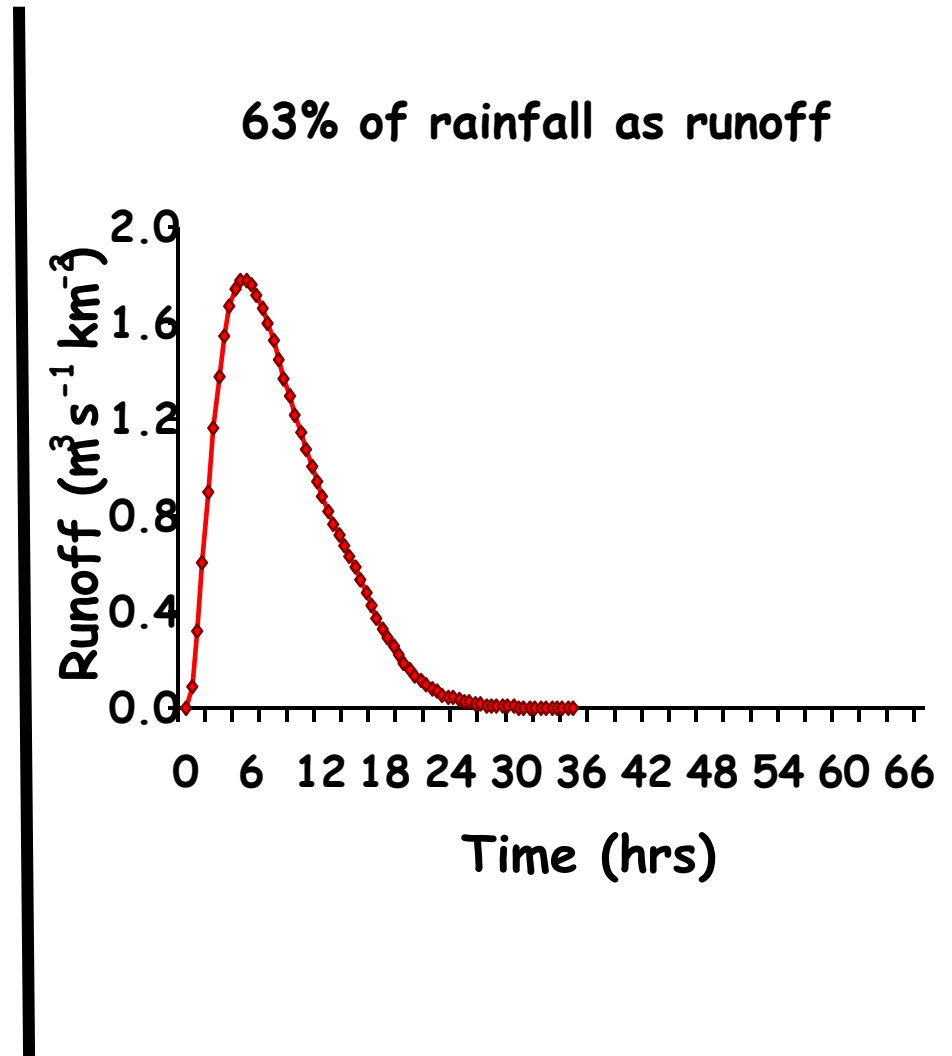
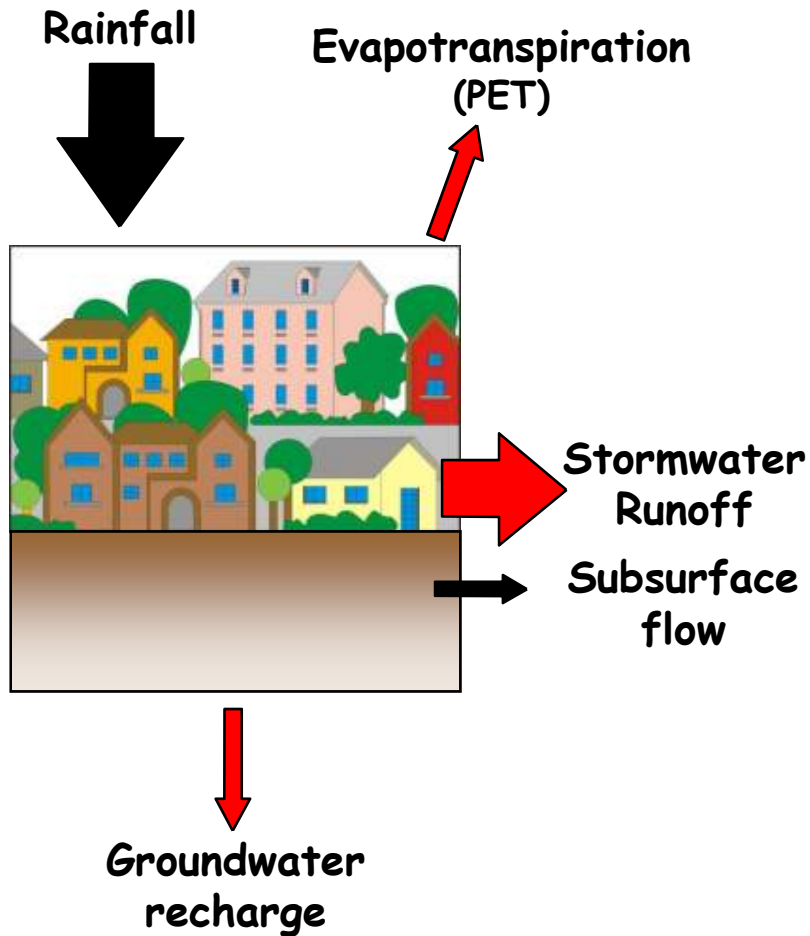
Requirements for small projects

Stormwater Management and Sediment and Erosion Control Plan Review Checklist For Design Professionals

# Water Budgets: Forested Watershed



# Water Budgets: Developed Watershed



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STORMWATER PONDS IN THE COASTAL ZONE

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Non-technical audience

~40 SC studies reviewed

Report uses so far...

- Bluffton (Jeff McNesby & Bob Klink)
- Fecal indicator bacteria models in the southeastern US (NOAA CCEHBR)
- LIDs in southeast (SCSGC/Oak Terrace)
- Center for Watershed Protection/GA Coastal Stormwater Supplement
- Beaufort Stormwater Utility Board
- Downloaded >500 times in 2008

# Water Quality

Pond surface water is often poor

- Nutrients, algae, chemicals, pesticides, fecal coliform, DO
  - High monthly mean DN (47%) and DP (100%) (DN > 0.37 mg/L and DP > 0.036 mg/L) (Serrano, 2005)
  - Low TN (71%) and TP (69%) in coastal ponds (n=112) (TN < 0.95 mg/L and TP < 0.09 mg/L) (Drescher et al., 2007)
  - High nutrients in six ponds studied over five years on Kiawah Island
    - Used multiple chemical and biological parameters (Brock, 2007)



# Water Quality: Algae

- 2001 - PLOs found in SC (Lewitus and Holland, 2003)
- 2002 fish kill in Mt. Pleasant linked to *Karlodinium micrum* bloom (Kempton et al., 2002)
- Persistent algal blooms on Kiawah Island (Brock, 2007)
- High chl a (32%) in coastal ponds (n=112) (chl a > 40 µg/L) (Drescher et al., 2007)
  - Algal blooms in 80% of samples with chl a > 60 µg/L
- SC Task Group on HABs and SCDHEC Emergency Response line



# Water Quality: Fecals

- Pet waste sources
  - High monthly mean fecals (5/15 mo.) (FCB > 200 CFU/100 mL) (Serrano, 2005)
  - Wildlife contributions and human sources related to land cover (Porter et al., 2005)
- High levels
  - High fecals (23%) in ponds (n=112) (FCB > 400 CFU/100 mL) (Drescher et al., 2007)
  - 5000% higher 24 hrs after rain (Messersmith, 2007)
  - High fecals 11% and 20% at two sites in Sea Pines from 1999-2005 (FCB > 1600 CFU/100 mL) (Skigen, 2005a; Skigen, 2005b)
  - Fecals higher after rain and likely from wildlife (Siewicki et al., 2007)



# Water Quality

- Chemical Contaminants

- Atrazine, chlorothalonil, and 2,4-D found in pond (Serrano, 2005)
- Higher, more frequent detection during summer months at Kiawah Island (USES, 2006)
  - 10 ponds sampled for 6 pesticides and herbicides every 6 wks.
- Ponds decreased pharmaceuticals (Cooper, 2007)



- Debris and trash

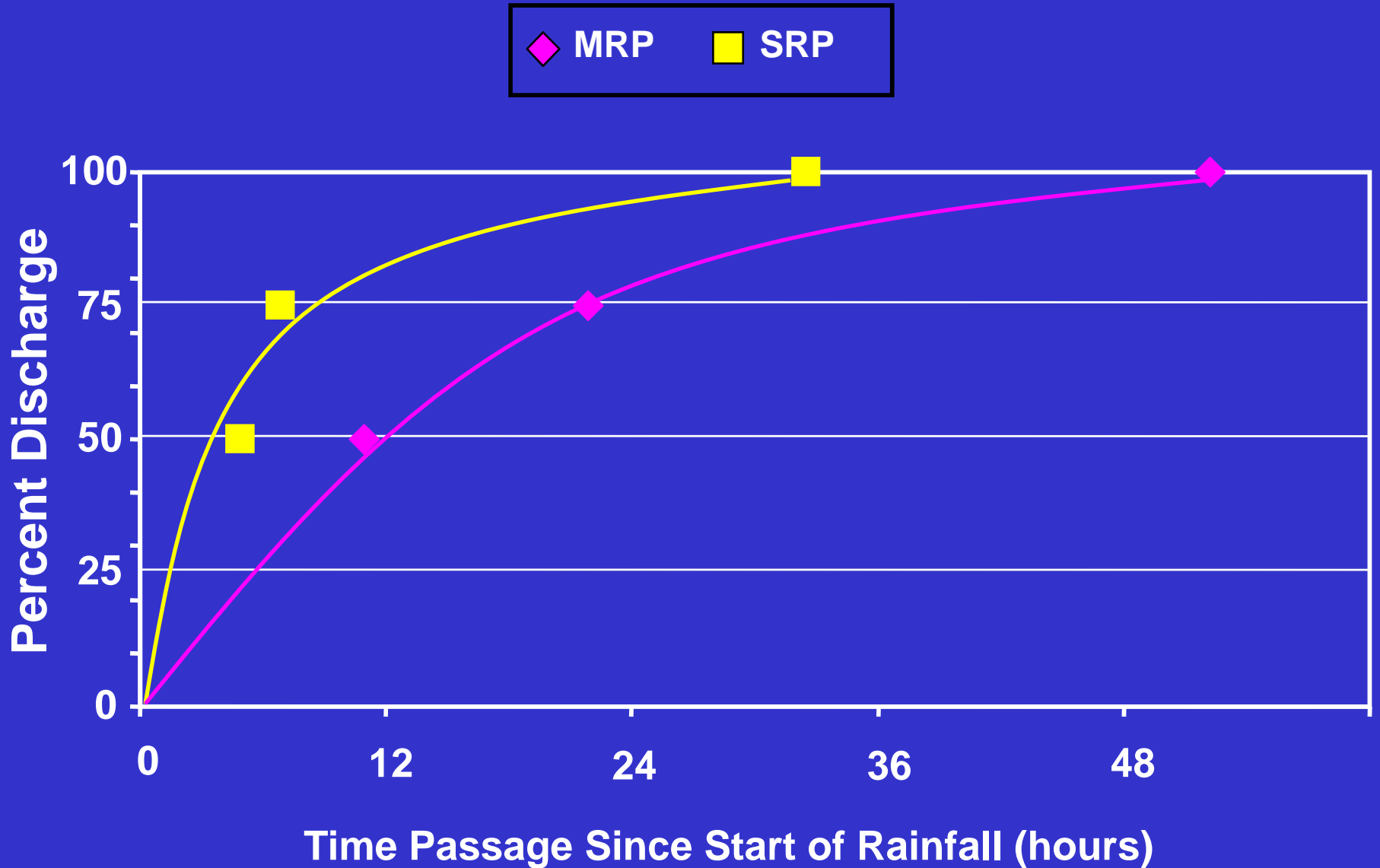


# Pollutant Removal Efficiencies

- Removals: Nutrient(– 208% to 95%), FCB (– 477% to 99%), & TSS (– 79% to 91%) and terminal pond in a series had better pollutant removal than single pond (Messersmith, 2007)
- Bacteria, nutrients, and algae varied for three NC ponds (Mallin et al., 2002)
- Removal efficiencies were higher after retrofitting a pond with a forebay and wetland (Libes and Bennett, 2003)
  - Retrofitting Efficiencies: TSS (75 to 90%), fecals (80 to 98%),  $\text{NO}_3 + \text{NO}_2$  (42 to 96%),  $\text{NH}_4$  (62 to 95%), &  $\text{PO}_4$  (23 to 97%)



# Percent Discharge



# Pond Efficiencies

<b>Pollutant</b>	<b>Single Pond</b>	<b>Multiple Pond</b>
Fecal Coliform Bacteria	14%	55%
Total Suspended Solids	19%	88%
Total Nitrogen	-2.5%	39%
Total Phosphorus	-6%	71%

# Stormwater Pond Research

- **Hydrology** (High water table and sandy soils)
  - Groundwater potential source of nutrients to two ponds at Kiawah Island (Bunker, 2004)
    - Wetland model developed
- **Sediments**
  - Below background PAHs found at Kiawah Island (Flemming, 2006)
  - Ponds losing storage capacity over time (Messersmith, 2007)
    - 36% loss for single pond and 15% loss for pond in series



# Pond Sediments

- Measure chemical and biological contaminants in sediment
- Is sediment contamination linked to land use, drainage area, age of pond, maintenance practices, or impervious surface in watershed?
- Identify contaminants of ecological and human health concern



# Pond Sediments

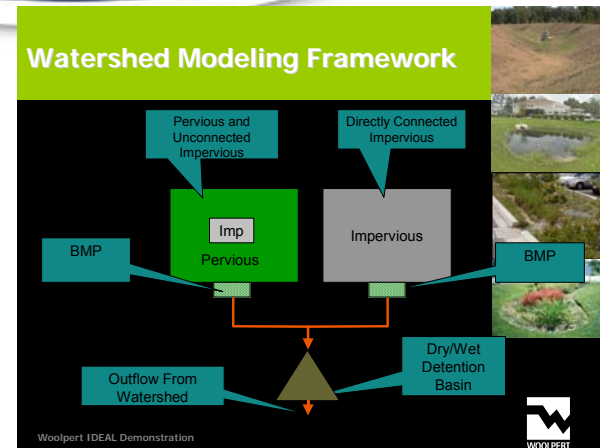
- Commercial ponds had higher PAHs
- Pond drainage area and surface area were related to PAH, Cu, Pb, Zn, & chlorpyrifos
- No evidence of acute toxicity
- Commercial ponds and residential ponds with large drainage areas more likely to be contaminated
- PAH levels in contaminated ponds sediments exceeded several toxicological benchmarks for both ecological and human health



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The Citadel  
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# Stormwater Pond Research

- **Modeling** (High water table and sandy soils)
  - TR 55, ICPR, Hydrocad, etc.
  - IDEAL model
  - Not SC coast specific and not ground-truthed



- **Social Sciences**

- > ½ residents willing to change land use practices to improve water quality (Serrano, 2005)
- Alternative BMPs (eg, LIDs): 1) Need to determine short-term and long-term effectiveness; 2) lack of research; 3) inability to meet regulatory guidelines; and 4) permit difficulty (Martin, 2006)

# Report includes....

- Education and Outreach
- Research and Information Needs
- Management Implications
  - Maintain, monitor, inspect, and provide information
  - Encourage innovative stormwater management (LIDs, buffers, and other BMPs)



## Permanent Stormwater System Maintenance and Responsibility Agreement

Under the South Carolina Stormwater Management and Sediment Reduction Act of 1991 (48-14-10, et. seq.), Regulation 72-308 requires the Landowner, its successors and assigns, including any homeowners association, shall adequately maintain the stormwater management/Best Management Practices (BMP) facilities. This includes all pipes and channels built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions.

The Department of Health and Control (DHEC)/Office of Ocean and Coastal Resource Management (OCRM) recommends that The Landowner, its successors and assigns, shall inspect the stormwater management/BMP facility regularly. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facilities, berms, outlet structure, pond areas, access roads, etc.

The Landowner, its successors and assigns, hereby grant permission to the DHEC/OCRM, its authorized agents and employees, to enter upon the Property and to inspect the stormwater management/BMP facilities whenever DHEC/OCRM deems necessary. The purpose of inspection is to follow-up on reported deficiencies and/or to respond to citizen complaints. DHEC/OCRM shall provide the Landowner, its successors and assigns, copies of the inspection findings and a directive to commence with the repairs if necessary.

The Landowner, its successors and assigns, will perform the work necessary to keep these facilities in good working order as appropriate. In the event a maintenance schedule for the stormwater management/BMP facilities (including sediment removal) is outlined on the approved plans, the schedule will be followed.

This Agreement imposes no liability of any kind whatsoever on DHEC/OCRM and the Landowner agrees to hold DHEC/OCRM harmless from any liability in the event the stormwater management/BMP facilities fail to operate properly.

I accept responsibility for ownership and proper maintenance of the stormwater system (pond, swales, etc.) on the \_\_\_\_\_ site per the approved maintenance plan. I will complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a stormwater management device(s).

It is my understanding that the maintenance plan may be amended/revised at any time by DHEC/OCRM, and I will abide by any prescribed changes.

I will continue to own and maintain the pond until DHEC/OCRM is notified in writing of a transfer in ownership and maintenance responsibility. The notification will include a date for the transfer of responsibility and a letter of acceptance from the new owner.

I understand that failure to adhere to the sign maintenance agreement may result in fines of up to \$1,000.00 per day, per violation and /or the institution of a court action.

Signature of Owner/Agent \_\_\_\_\_ Printed Name of Owner/Agent \_\_\_\_\_ Date \_\_\_\_\_

Mailing Address \_\_\_\_\_ City/State/Zip \_\_\_\_\_ Phone Number \_\_\_\_\_

Notary Stamp/Signature/Date \_\_\_\_\_



Required to maintain stormwater BMP

Inspection allowed anytime

Notify in writing to OCRM for ownership transfers

Associated fines possible



Photo courtesy of Dr. John Weinstein.

# Maintenance

<http://www.scdhec.net/environment/water/docs/erfchecklist.doc>

- ✓ Maintenance plan description
- ✓ Schedule of maintenance procedures
- ✓ Detailed description of non-traditional, proprietary, or underground controls
  
- ❖ Typical items addressed
  - Grass mowed
  - Trees removed from pond
  - Trash & sediment removal from pond & outlet
  - Orifice cleaning
  - Outlet pipe cleaning, inspection, & repair
  - Sediment removal
  - Energy dissipator cleaning & repair
  - Side slope erosion measures



# D H E C



PROMOTE PROTECT PROSPER

## Stormwater System Inspection Form

S. C. Department of Health and Environmental Control  
Office of Ocean and Coastal Resource Management  
1362 McMillan Avenue, Suite 400  
Charleston, South Carolina 29405

(843) 747-4323  
(843) 744-5847 (fax)

THIS FORM IS TO BE USED FOR INSPECTION OF PROJECTS AUTHORIZED UNDER AN ISSUED OCRM PERMIT

Name of Inspector Greg wahl	NPDES Coverage? Y <input type="checkbox"/> N <input type="checkbox"/> N/A <input checked="" type="checkbox"/> Approved Plans Onsite? Y <input type="checkbox"/> N <input type="checkbox"/>	Type of inspection: (circle one) Final <input type="checkbox"/> Wastewater & Water Supply <input type="checkbox"/> Stormwater Inspection <input type="checkbox"/> Stormwater Maintenance <input checked="" type="checkbox"/>
Project Name Ricefields ph 8	Permit Number XXXX	
County Georgetown	Disturbed Area Stabilized? Y <input type="checkbox"/> N <input type="checkbox"/> N/A <input checked="" type="checkbox"/>	EFIS Number XXX
Site Location Adj. Caledonia & Kings River Rd. Pawley's Island	Access for Maintenance Inspection: (check one) Acceptable <input checked="" type="checkbox"/> Not Acceptable <input type="checkbox"/>	
Waterbody Waccamaw	Acceptable Sediment Control: Y <input type="checkbox"/> N <input type="checkbox"/> N/A <input checked="" type="checkbox"/>	BMP Types(s) wet detention

ITEMS INSPECTED: (AS APPLICABLE)	ACCEPTABLE	NOTACCEPTABLE	REQUIRED MAINTENANCE/NOTES
-------------------------------------	------------	---------------	----------------------------

ITEMS INSPECTED: (AS APPLICABLE)	ACCEPTABLE	NOTACCEPTABLE	REQUIRED MAINTENANCE/NOTES
<b>Embankments</b>			
Vegetation & ground cover	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Erosion	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Debris	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

<b>Inlets</b>			
Pipe condition (e.g., cracks, corroded metal)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Energy dissipation (e.g., rip rap aprons)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Slopes	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Roof drainage	<input type="checkbox"/>	<input type="checkbox"/>	
Flumes	<input type="checkbox"/>	<input type="checkbox"/>	

<b>Outlets</b>			
Vegetation & ground cover	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Energy	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

# Acknowledgments

*We appreciate the generous support of the following individuals:*

- *Melissa Rada, SCDHEC-OCRM*
- *Janice Flory, Univ. of GA*
- *Drew Zurow, GA DNR*
- *Jeannie Butler, GA DNR*
- *Gloria Putnam, NC Sea Grant*
- *Patricia Hughes, NC Div. of Water Quality*
- *Debra Hernandez, Hernandez & Company, LLC.*
- *Dr. Dan Hitchcock, Belle W. Baruch Institute of Coastal Ecology and Forest Science and Clemson University*
- *Dr. John Weinstein, The Citadel*

*and many others who shared their insights and assisted in editing the report.*

# Questions.....

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Report available at: [http://www.scdhec.net/environment/ocrm/science/docs/SOK\\_Ponds.pdf](http://www.scdhec.net/environment/ocrm/science/docs/SOK_Ponds.pdf)



Golf course in M. Beach to

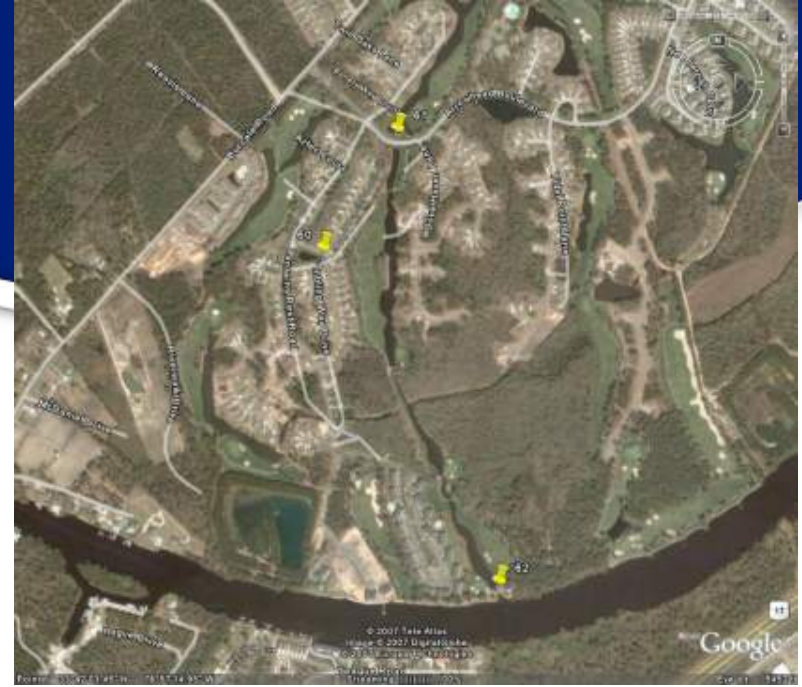


Spill way over rip rap to



Intercoastal Waterway

- Connectivity
- Cumulative effect



Golf course in M. Beach to



Spill way over rip rap to



Intercoastal Waterway

# Education and Outreach

- National Estuarine Research Reserve System (NERRS) Coastal Training Programs
- SC's Non-point Education for Municipal Officials program (SC NEMO)
- South Carolina Home-A-Syst (Homestead Assessment System)
- Clemson's Carolina Clear Program
- Coastal Waccamaw Stormwater Education Consortium
- Ashley Cooper Stormwater Education Consortium

# Management Implications

- Continue stormwater system inspections
- Encourage innovative stormwater management (e.g., LIDs, buffers, and other BMPs)
- Examine data gaps/obstacles for alternative BMPs
  - Science
  - Management/Permitting
  - Development
  - Public perception
- Public education
  - Not natural lakes, but to collect stormwater
  - Where can locals go for help?



Photo courtesy of Elias Deeb

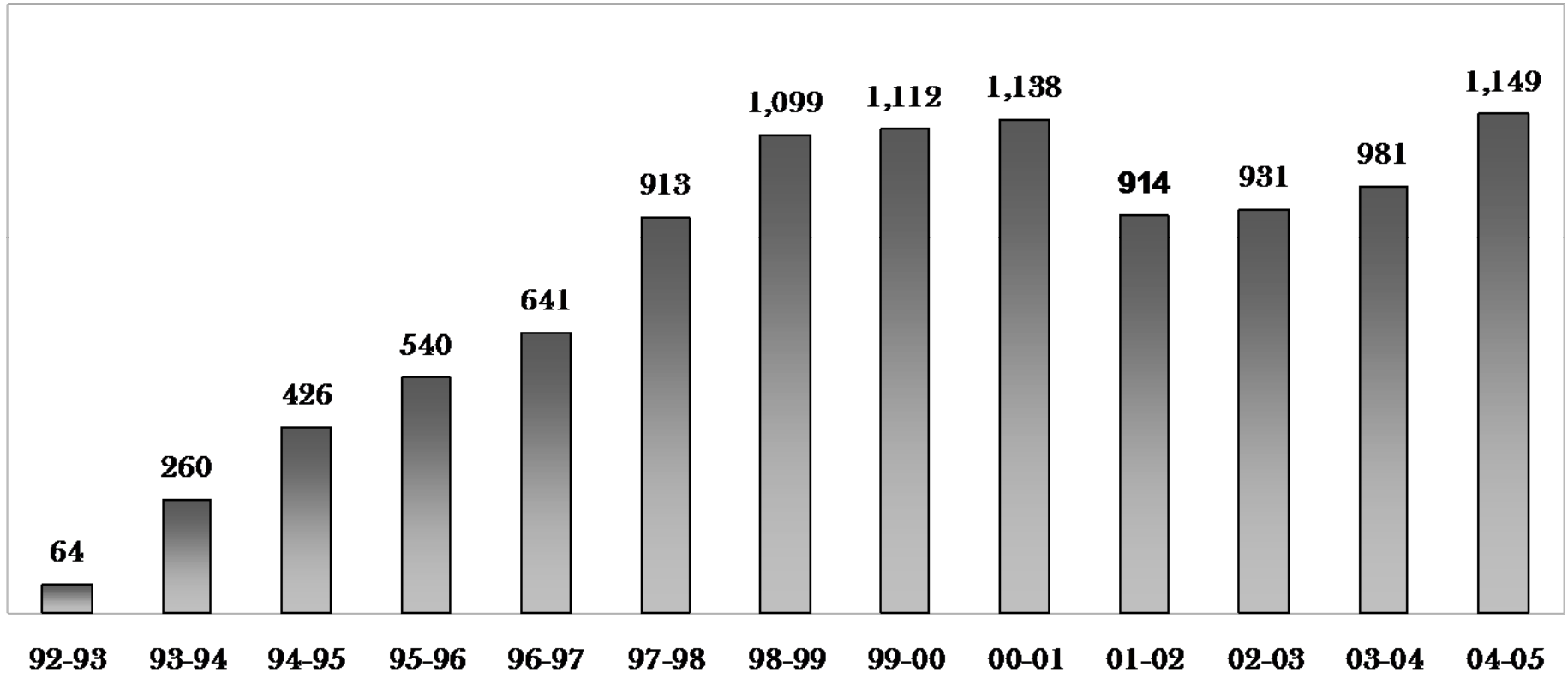
# Questions.....

Science and Policy Division  
SCDHEC-OCRM  
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<http://www.scdhec.net/environment/ocrm/>



# Coastal Stormwater Permits and Plans



# Research and Information Needs

- How many stormwater ponds exist in the SC coastal zone, what is their cumulative volume/coverage, and at what rate are they expanding?
  - Is there a need to classify stormwater ponds according to size, land use, type, etc.?
- What stormwater pretreatment procedures are most effective?
- What are common pond maintenance practices, and how do they affect pond structure and function?
- What are the impacts to receiving waters from stormwater pond discharges?
- How fast are stormwater ponds “filling in,” and what is the level of sediment contamination? How often is sediment removed from ponds? Where is the removed sediment placed/disposed?
- What water quality indicators and levels may indicate impaired pond conditions, or potential pollution sources for receiving waters?

# Research and Information Needs

- Would other stormwater pond design criteria (i.e., other than 2-year and 10-year rain events) better protect water quality and control water quantity (flooding)?
  - Are designed storm events (2- and 10-year rain events) reducing peak rates of flow to pre-development conditions? Are pre-development runoff rates accurate for SC's low topography?
  - What is the performance of stormwater ponds during small, frequent rain events versus large, infrequent rain events?
  - Which stormwater hydrologic model is most applicable in coastal SC?
    - » Which of the commonly used models have been validated for coastal SC?
- What public and environmental health risks might stormwater ponds pose?
- How can education and outreach to local governments and homeowners be improved?
- What are the economic costs and benefits of a stormwater pond? What are the comparative costs and benefits of more innovative stormwater management practices?

# Highlighted Future Projects

- ✓ Oak Terrace Preserve, N. Charleston (Vandiver, 2008)
  - LID BMPs vs traditional curb and gutter
- ✓ Bannockburn Plantation, Georgetown (Hitchcock, Jayakaran, and Williams, 2007)
  - Are LIDs feasible?
    - SCS-CN rainfall-runoff estimates in shallow water tables
- ✓ Ground-truthing storm event and runoff models (SCS-CN), Turkey Creek Watershed at USDA Forester Service Santee Experimental Forest (Amatya, La Torre-Torres, and Callahan, 2007)
  - Long term datasets
- ✓ Potential public health risk of ponds, Beaufort & Charleston Co. (Porter, pers. comm.)
- ✓ Poor pond health (water quality, fish kills, and benthos) links to pond morphology and water quality, Kiawah Island (Kelley, pers. comm.)
- ✓ Contamination of coastal pond sediments (Weinstein and Crawford, 2007)
  - Potential risk to wildlife and human health