The background image shows a coastal scene with a wooden dock extending into a body of water. Several fishing boats are moored at the dock, with their masts and rigging visible. The water is calm, reflecting the sky. In the foreground, there is a grassy area with some wooden debris. The sky is overcast with grey clouds.

Integrating Stormwater Quantity and Quality Requirements using the Runoff Reduction Method Beaufort County, South Carolina

**Kentucky Stormwater Association
Annual Conference
Juen 27 – 29, 2018**

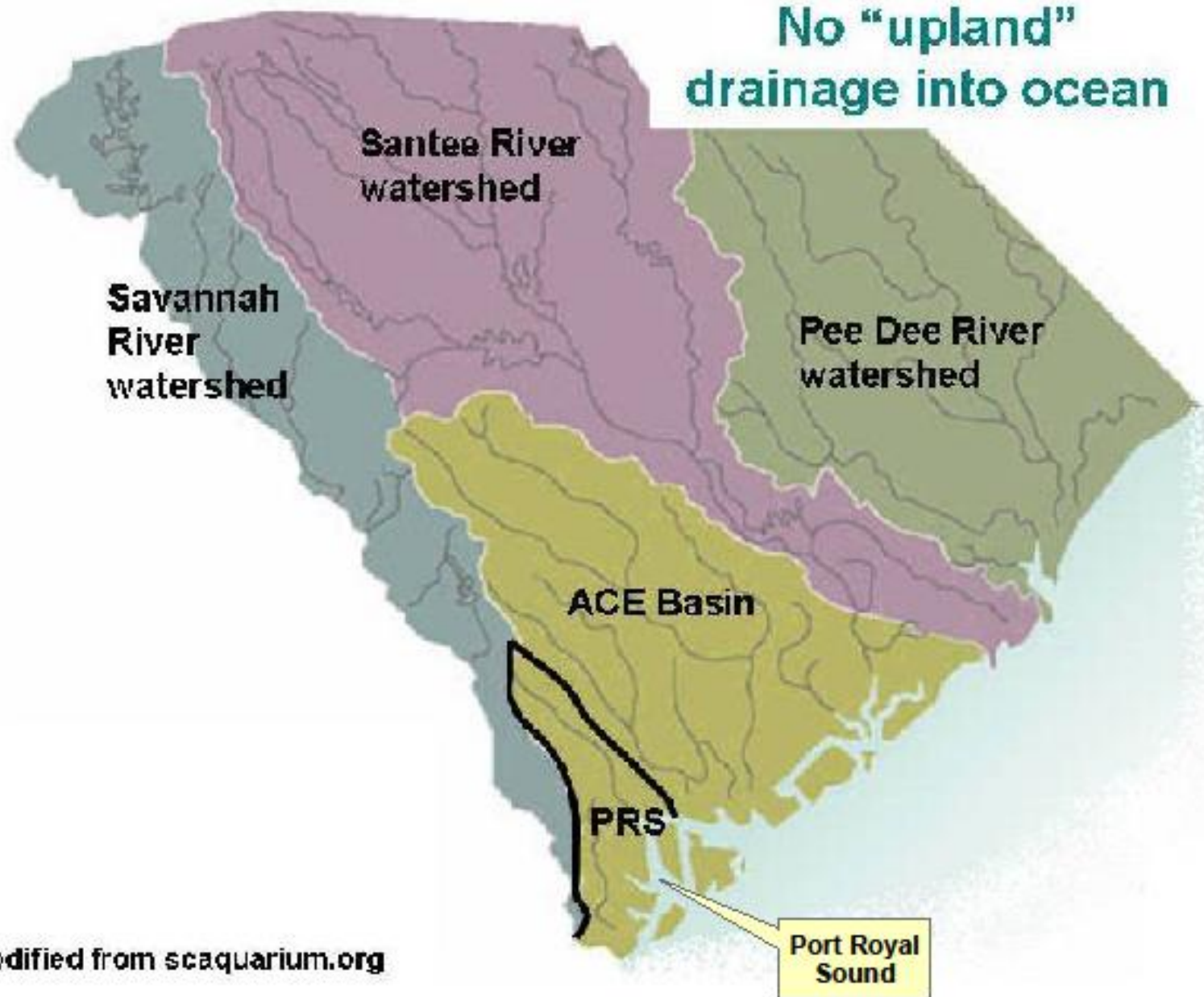
**Eric W Larson, PE, CPSWQ, AICP, CFM
Director of Environmental Engineering &
Land Management**



Characteristics

- Coastal County
- 50% Open and Salt Marshes
- Limited Freshwater Input
- High Tidal Amplitude
- Major Shellfish Harvesting
- Rapid Population Growth

**No "upland"
drainage into ocean**



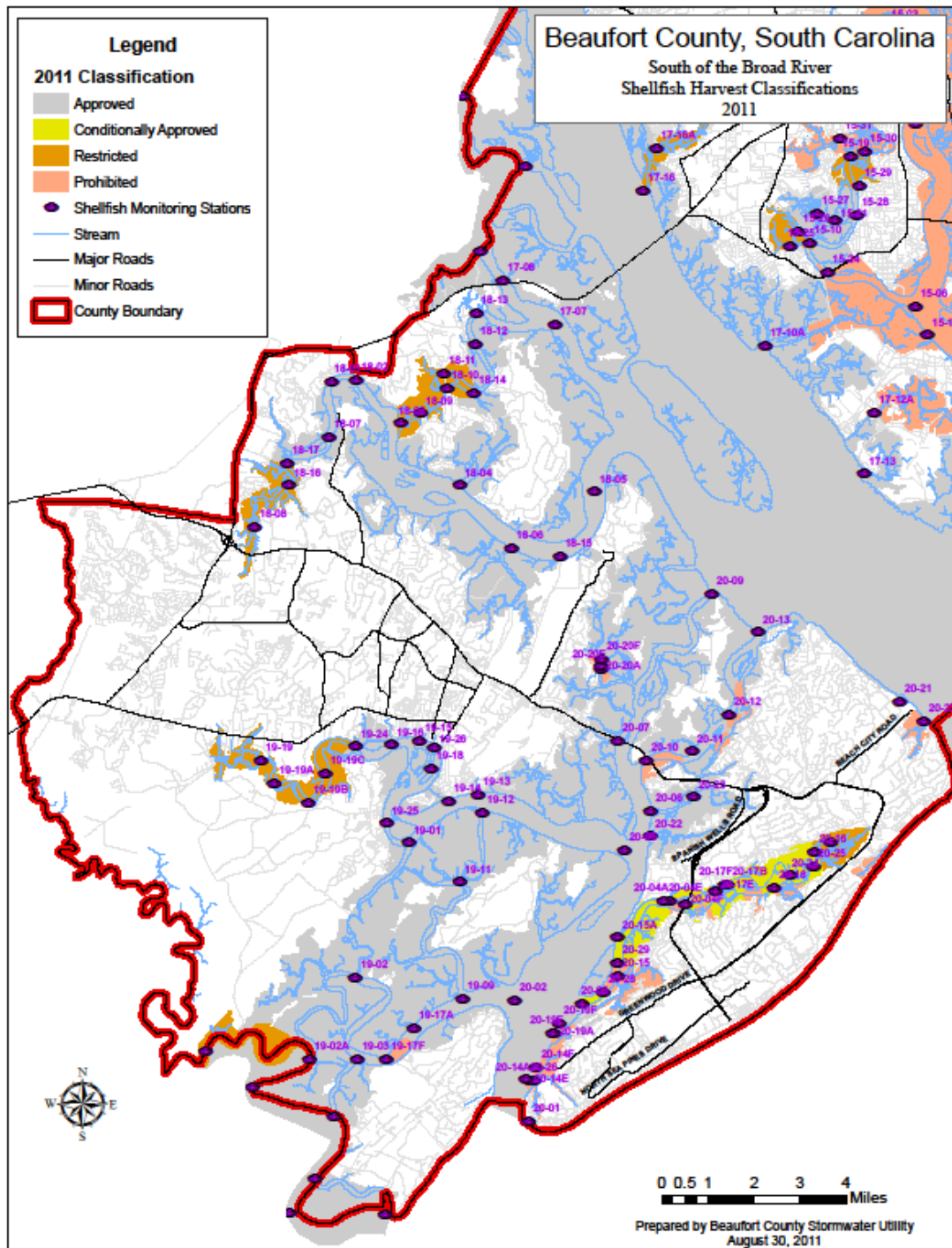
Modified from scaquarium.org

High Tidal Amplitude

HIGH TIDE = +9.5 ft.

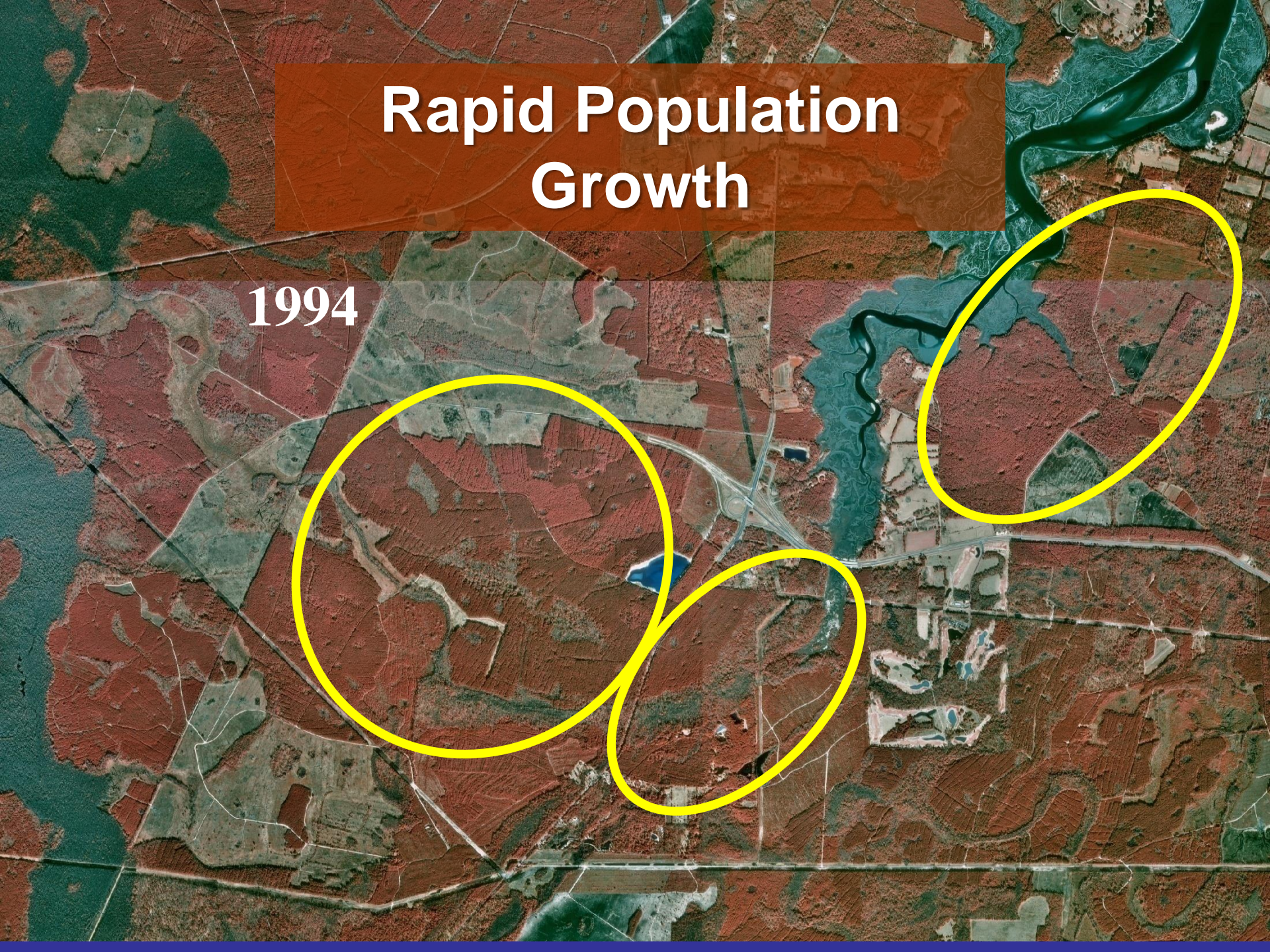
LOW TIDE = - 0.5 ft.

Shellfish Harvesting

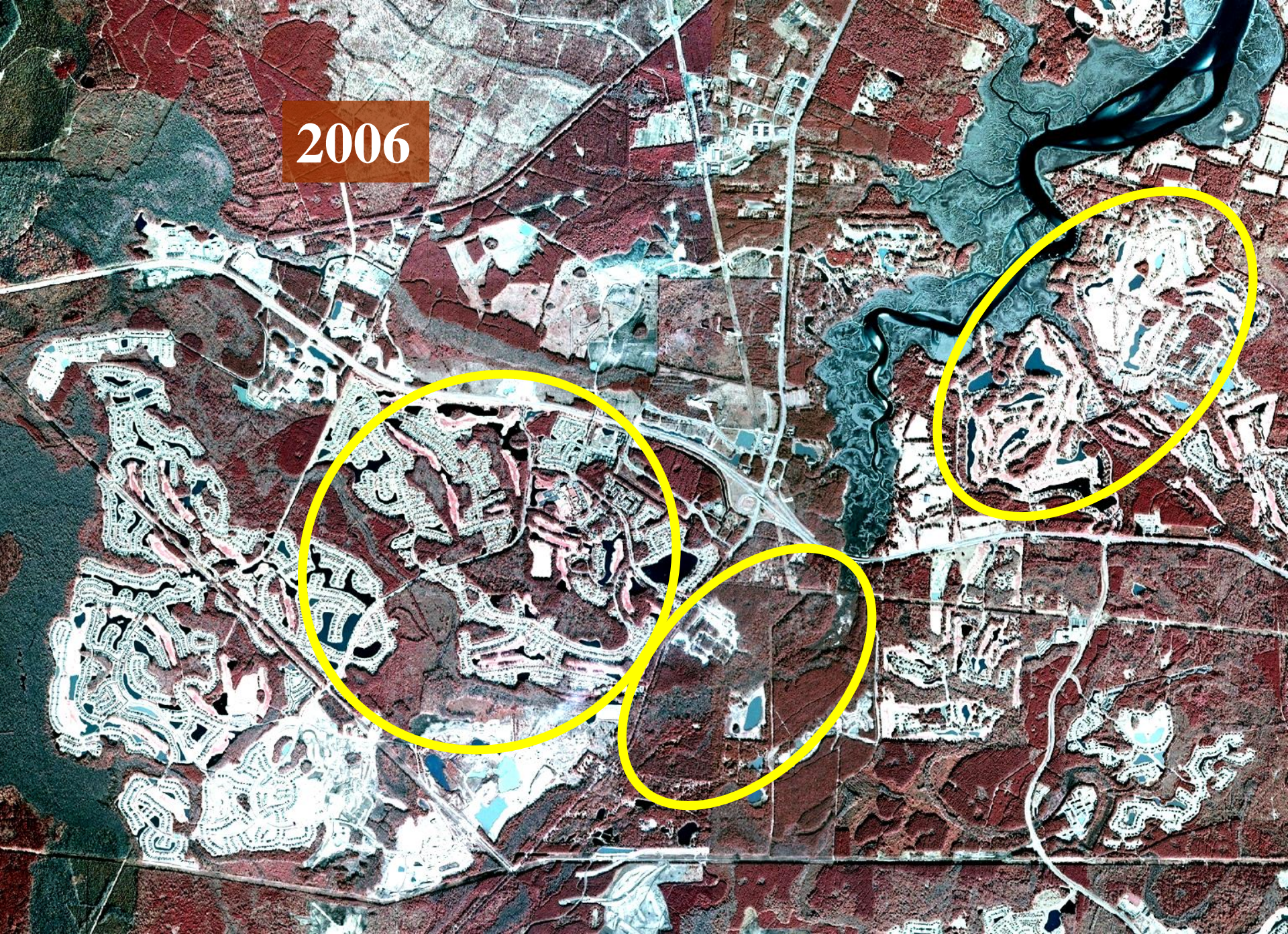


Rapid Population Growth

1994



2006



Impacts of Development on Runoff



- **New Development adds Impervious Surface**
- **Impervious Surface causes**
 - **An increase in rate of runoff**
 - **Pollutants are carried to receiving waters**
 - **An increase in total volume of runoff**

History of Stormwater Controls

- 1994 – Flooding leads to Peak Controls
- 1995 – Closing of Broad Creek in HHI leads to Clean Water Task Force
- 1998 – Adoption of First Water Quality requirements – First BMP Manual
- 1998-2009 – No closure of Shellfish Harvesting Areas- SW Plan - 2006
- 2009 – May River closure leads to Runoff Volume Controls

- Rose Dhu Watershed – Bacteria
- New River Wet Detention Pond – Bacteria
- Salinity Studies -Fresh Water inputs
- Water Budgets v. Natural Hydrology

Local Studies





HH-4

HH-5

Watershed

HH-2

HH-3

HH-6

MRR6

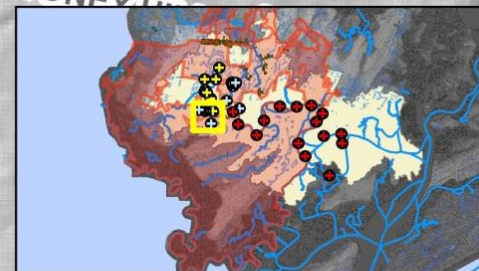
19-19

May River

Sampling Station Fecal Data

Station Date	January 6, 2011	January 12, 2011	January 19, 2011	January 26, 2011
HH4	N/A	N/A	N/A	770
HH5	N/A	N/A	N/A	866
HH2	6	11	3	14
HH3	7	5	4	6
HH6	4,082	1,072	1,245	582
MRR6	41	1,226	25	1,120

Town of Bluffton
New River watershed
basin project



OLD PALMETTO RD

NRP_IN_N
+
NRP_Out
+

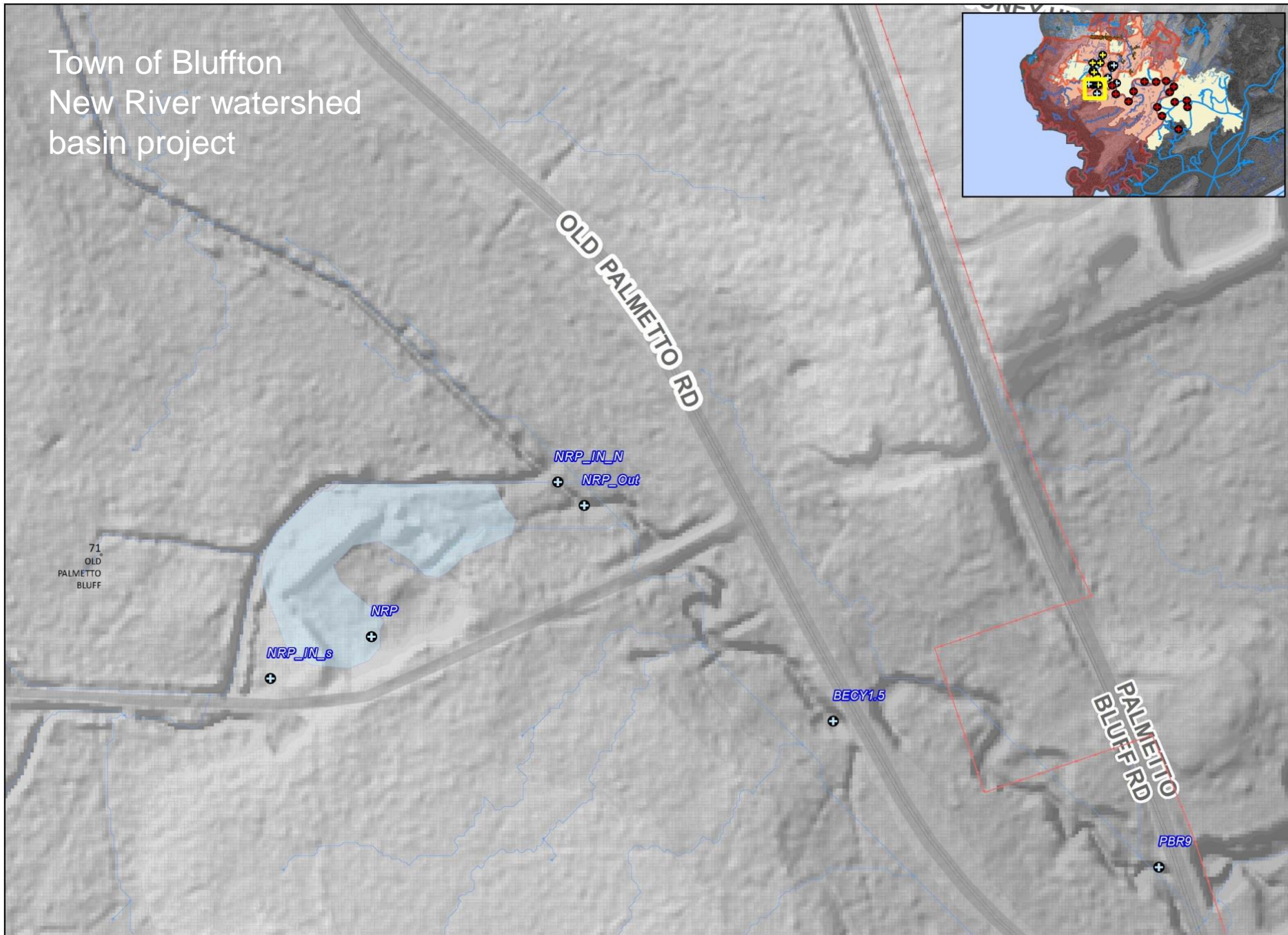
71
OLD
PALMETTO
BLUFF

NRP
+
NRP_IN_S
+

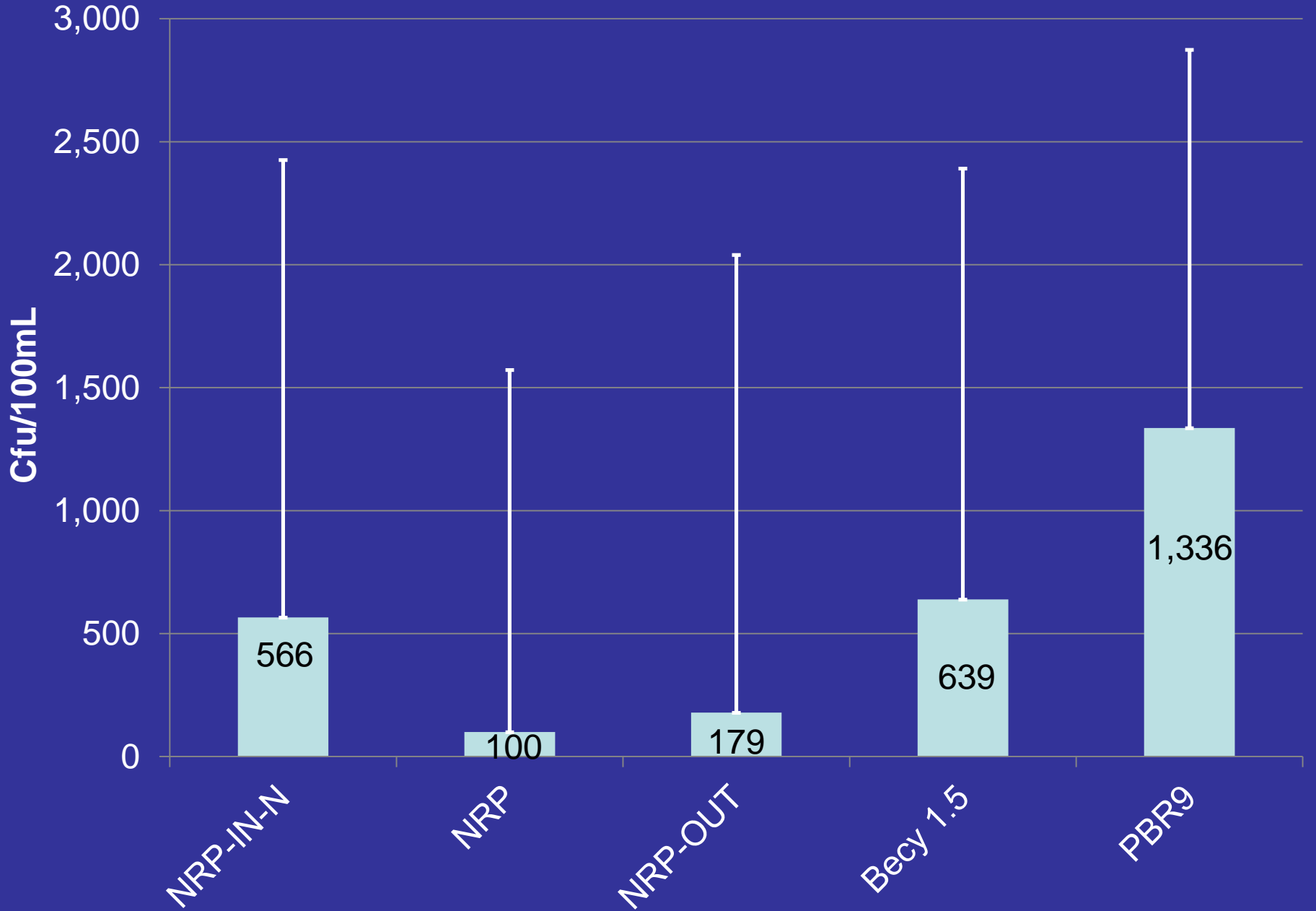
BEGY1.5
+

PALMETTO
BLUFF RD

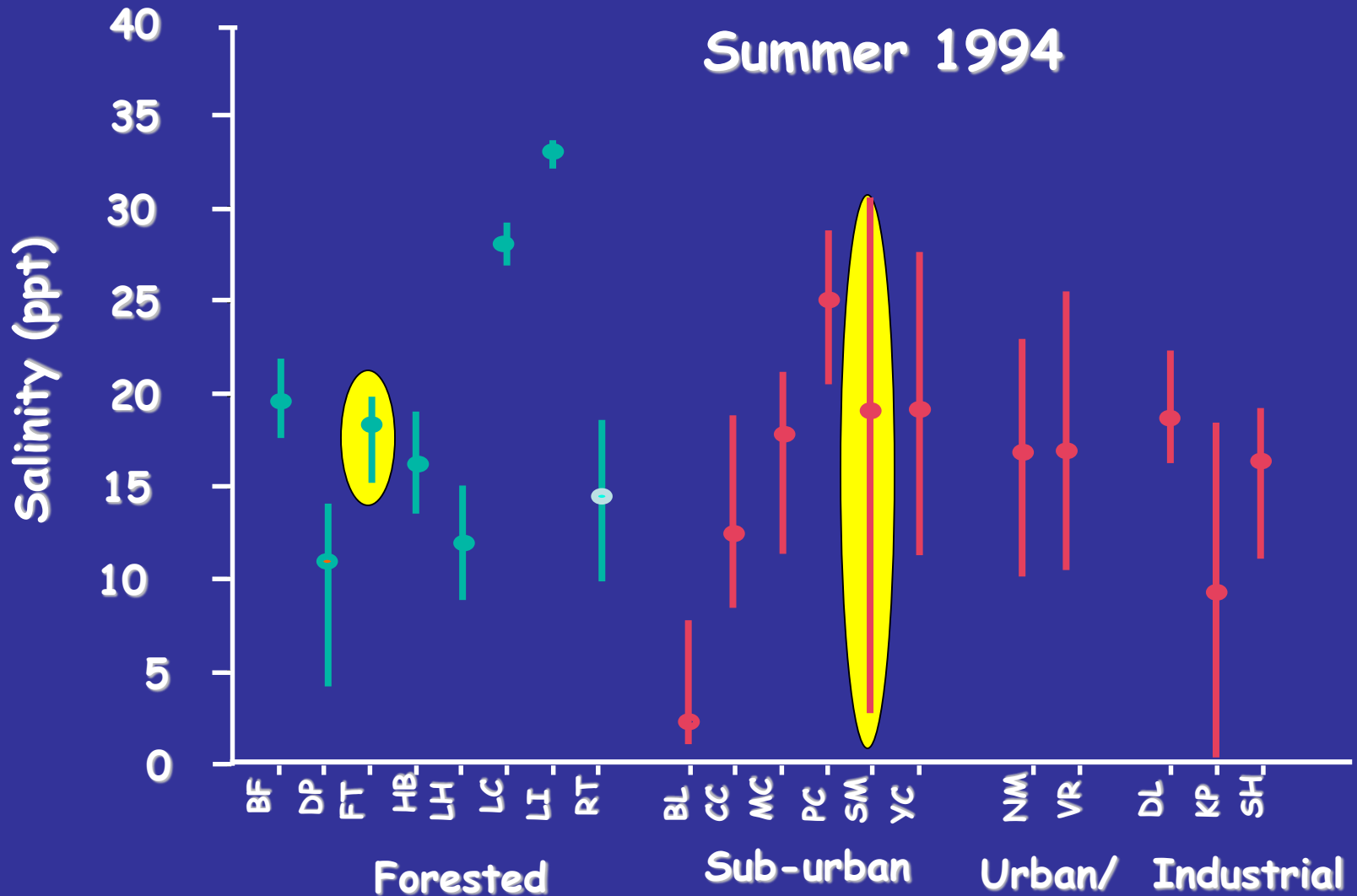
PBR9
+



■ Fecal Coliform GeoMean



Salinity Distributions

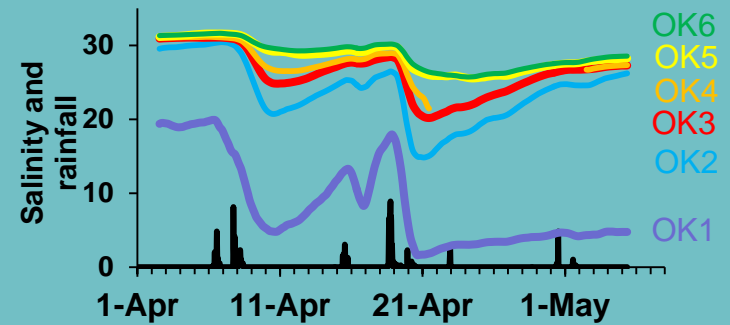
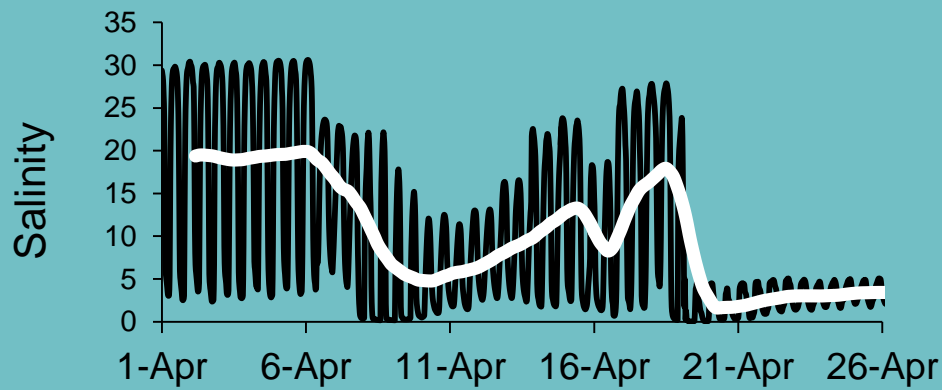
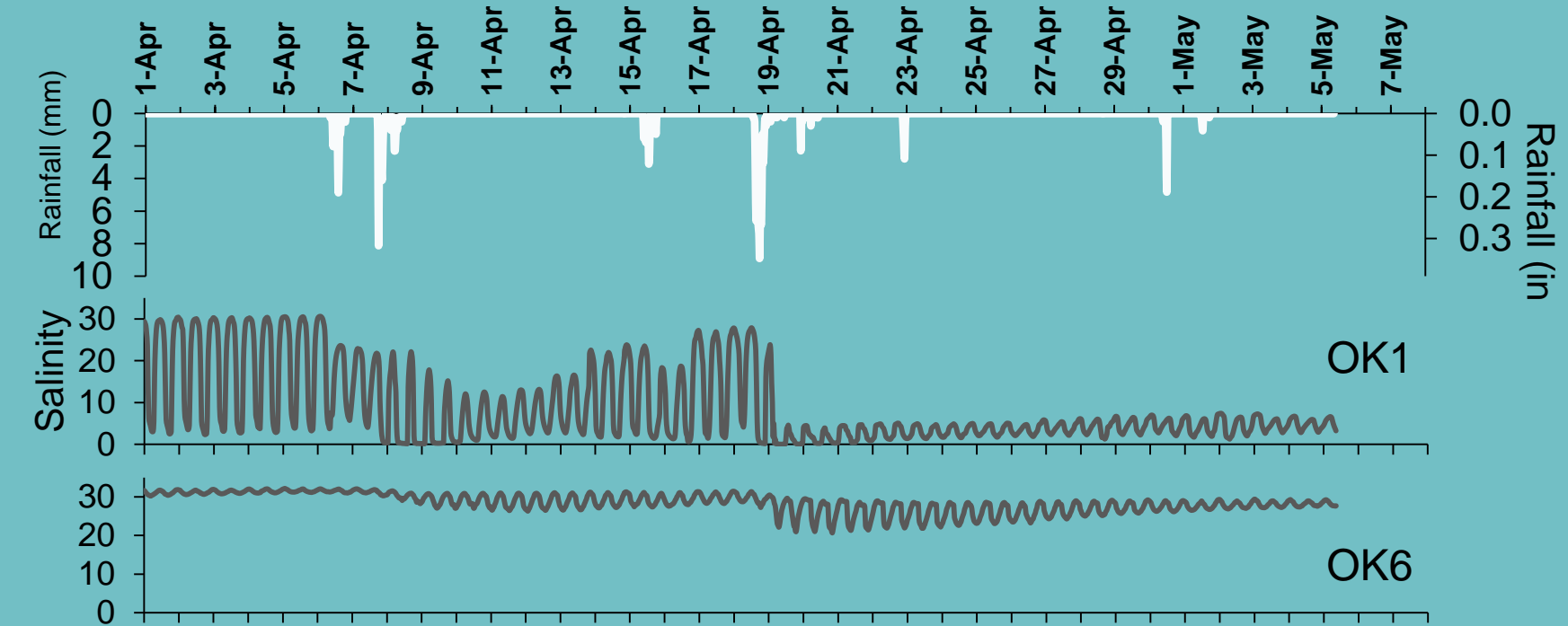


Okatie River Salinity Impacts

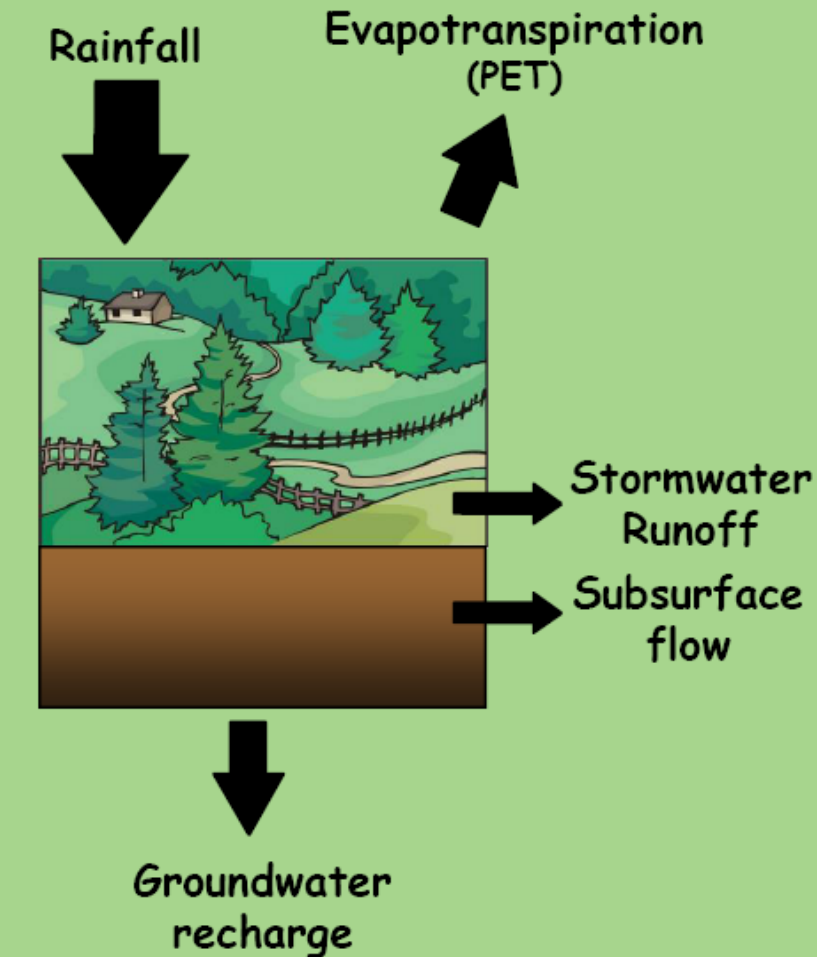
Okatie Sampling Sites & Watersheds



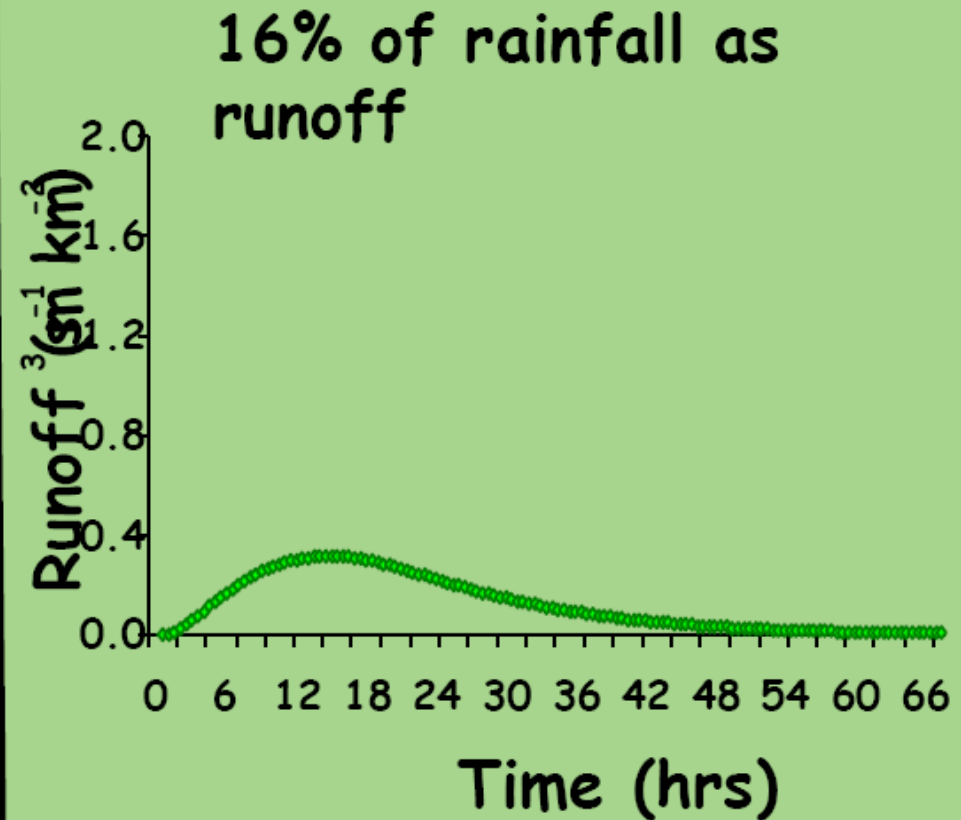
Okatie River Salinity Impacts



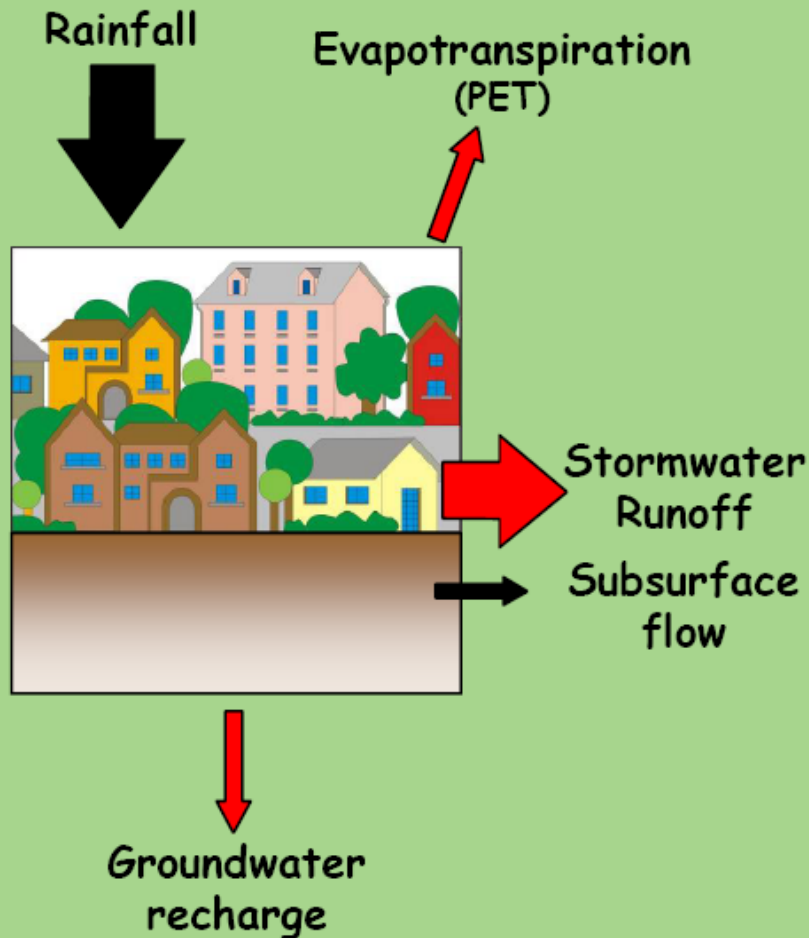
Water Budgets: Forested Watershed



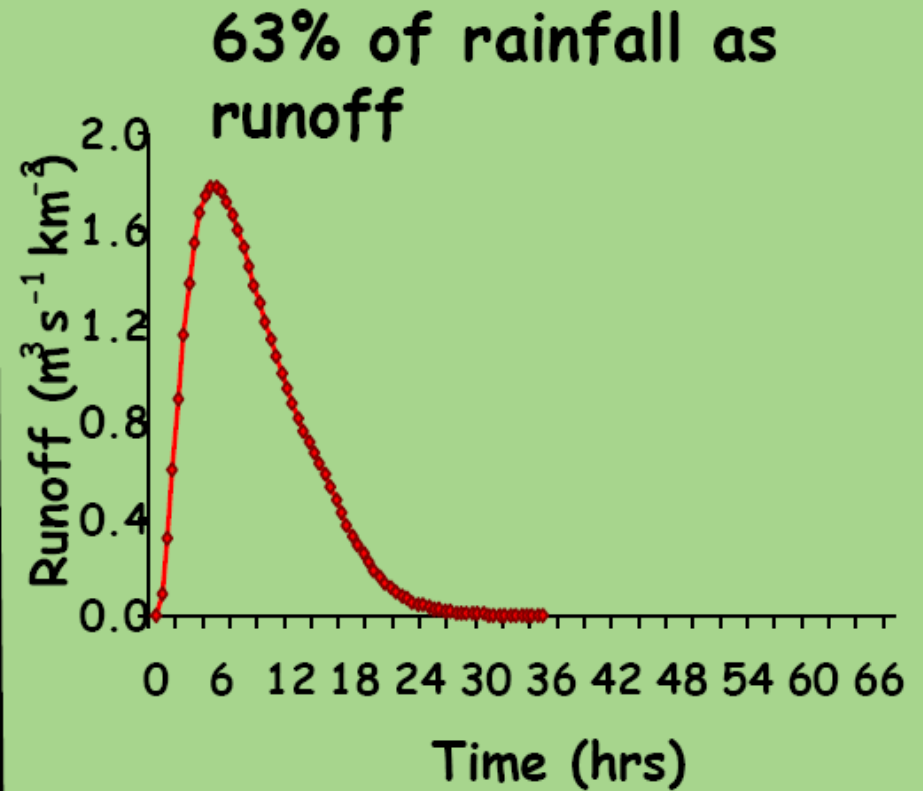
Forested Watershed



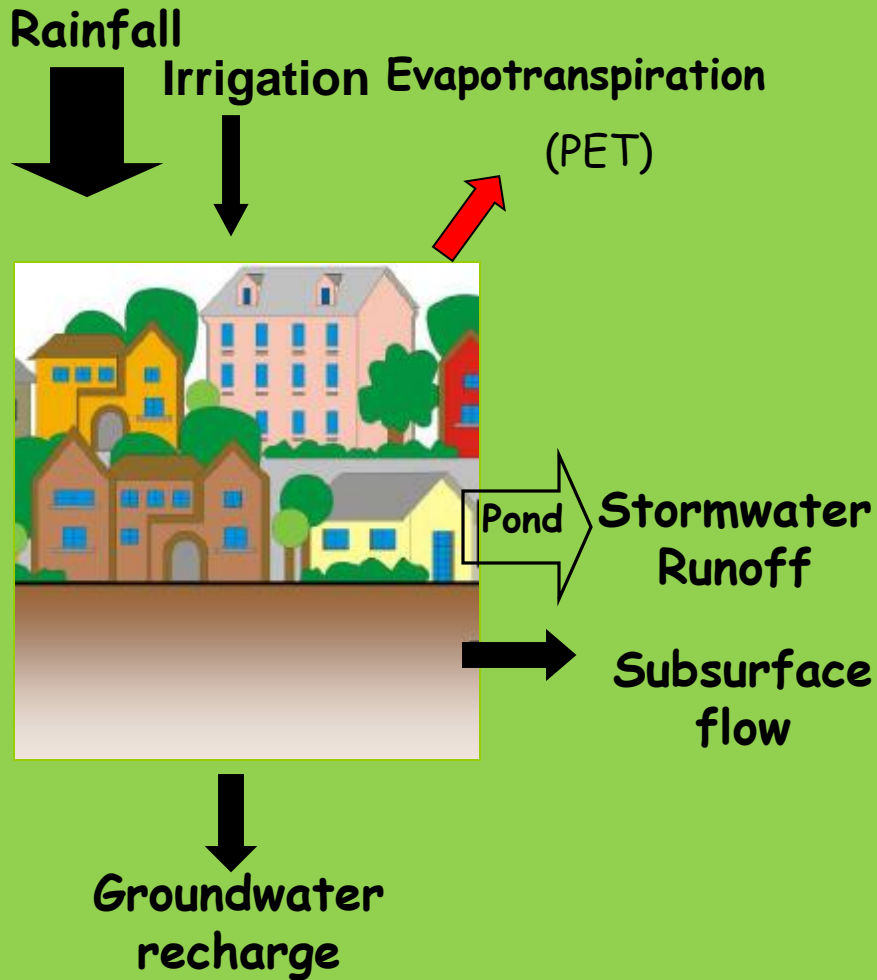
Water Budgets: Developed Watershed



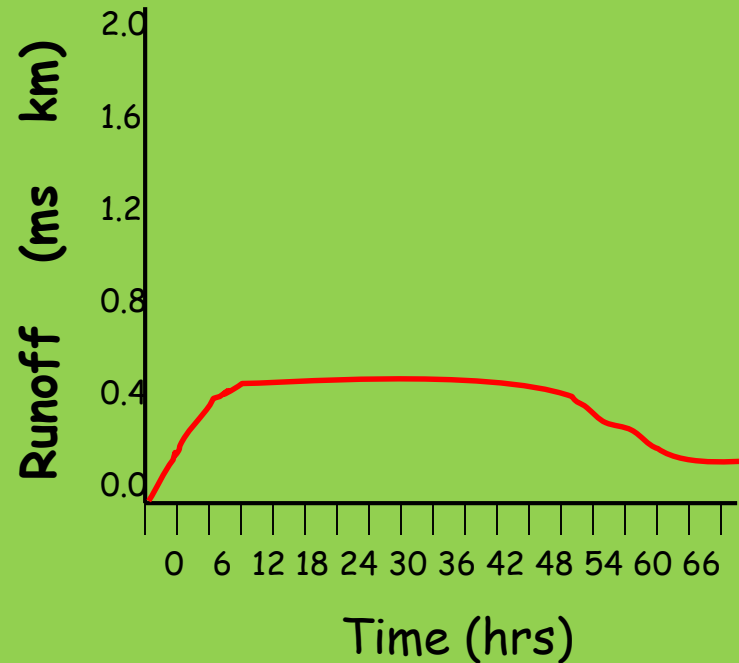
Developed Watershed



Water Budgets: Developed Watershed With Stormwater Controls

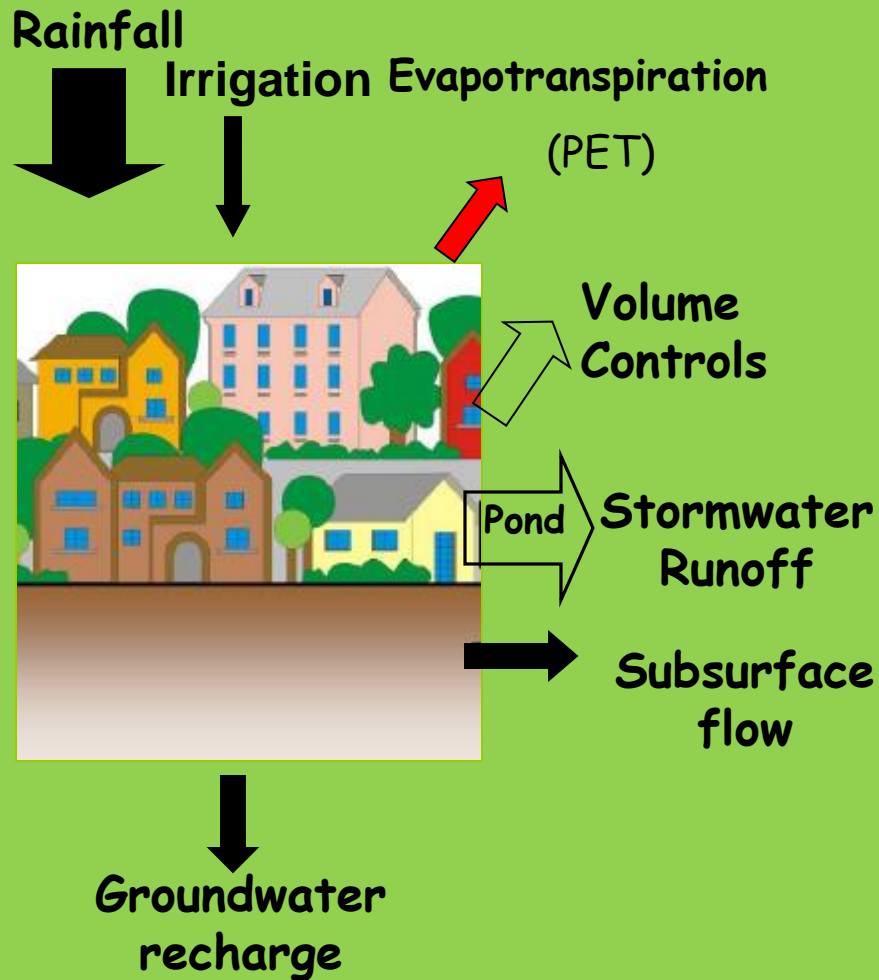


Peak same as Forested Watershed
Volume of Stormwater is Four Times
Forested Watershed



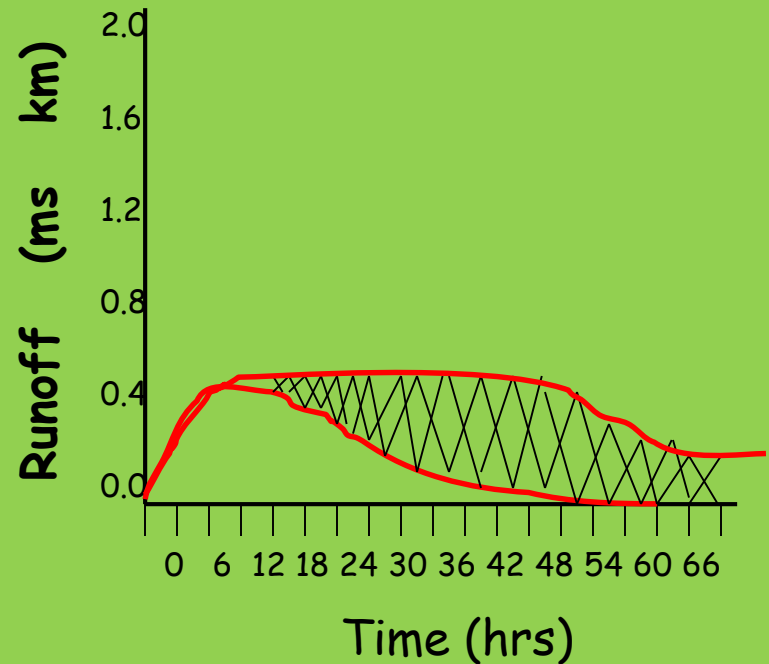
Developed Watershed

Water Budgets: Developed Watershed With Stormwater Volume Controls



Developed Watershed

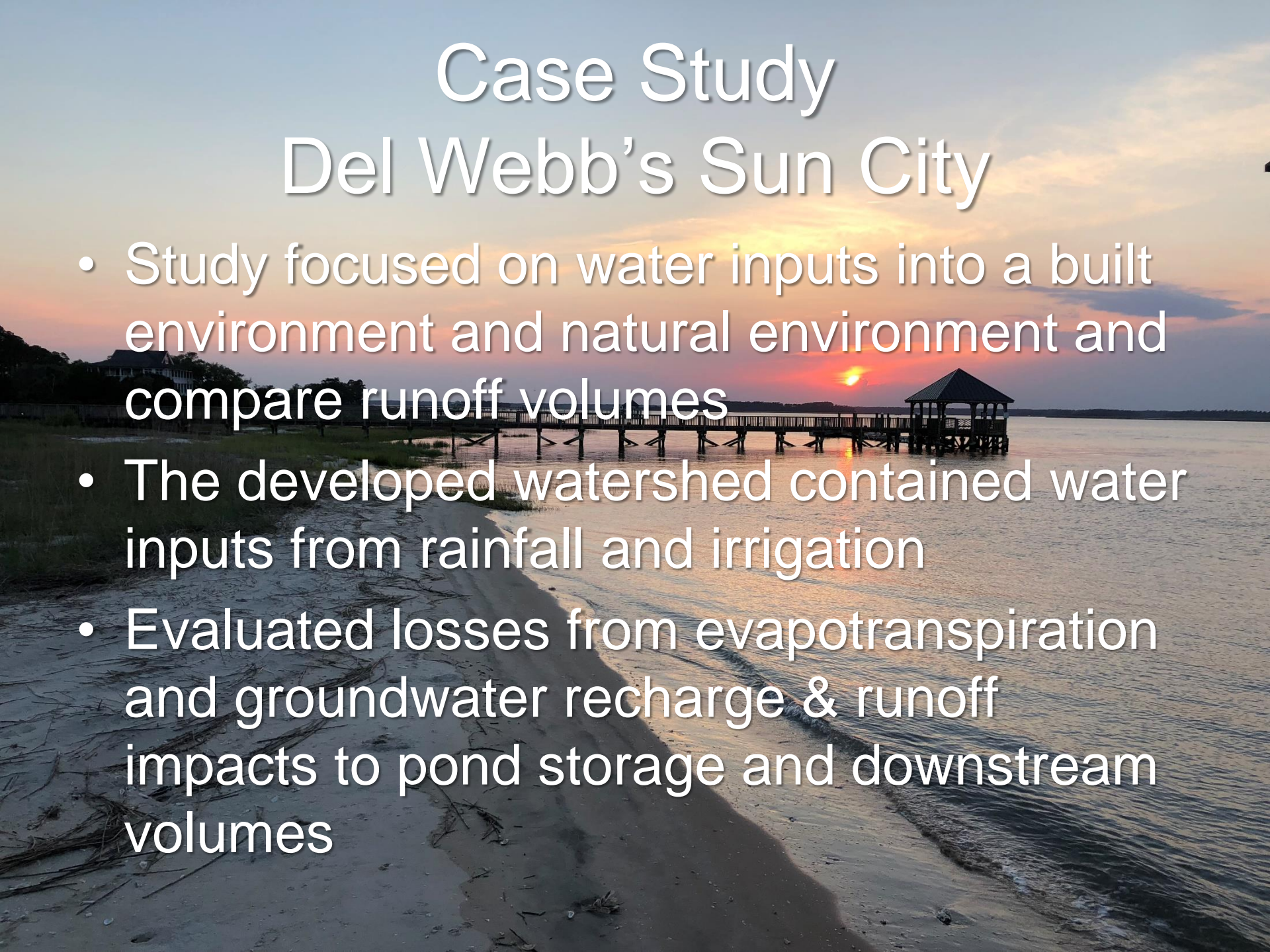
Peak same as Forested Watershed
Volume of Stormwater is Similar to
Forested Watershed



Case Study

Del Webb's Sun City

- Study focused on water inputs into a built environment and natural environment and compare runoff volumes
- The developed watershed contained water inputs from rainfall and irrigation
- Evaluated losses from evapotranspiration and groundwater recharge & runoff impacts to pond storage and downstream volumes



Case Study Conclusions

- Developed watersheds can contribute up to 50% more runoff
- Use of effluent or potable water sources for irrigation added on average another 20% to annual rainfall
- Better management of stormwater ponds was needed
- Alternate means to reuse or dispose of runoff was needed

The Regulations

(d) To the maximum extent technically feasible, no development or redevelopment shall cause post-development stormwater rates, quality or volume to increase above predevelopment levels or to cause an adverse increase in the surface runoff reaching adjacent or surrounding property or receiving waters. Surface runoff rate and volume shall be dissipated by detention or retention on the development parcel, percolation into the soil, evaporation, transpiration, reuse or by transport by natural or manmade drainageway or conduit (protected by legal easement) to a county-approved point of discharge.

BMP Manual Principles

Peak Controls



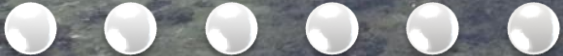
Water Quality Controls



Runoff Volume Controls



or, Impervious Cover Controls



Approved Design

Equivalent/Effective Impervious Cover (EIC)

- Metric that measures how effectively impervious surface runoff is reduced relative to pre-development pervious surface runoff
- 1998 –Adopts Antidegradation Goal on 10% Impervious Surface for Phosphorus
- 2003 - Adopts 5% goal for Bacteria
- 2009 – Adopts 10% goal for Nitrogen
- 2010 – Volume control of 95th percentile rainfall event is equivalent to 10 % EIC

Volume Control Requirements

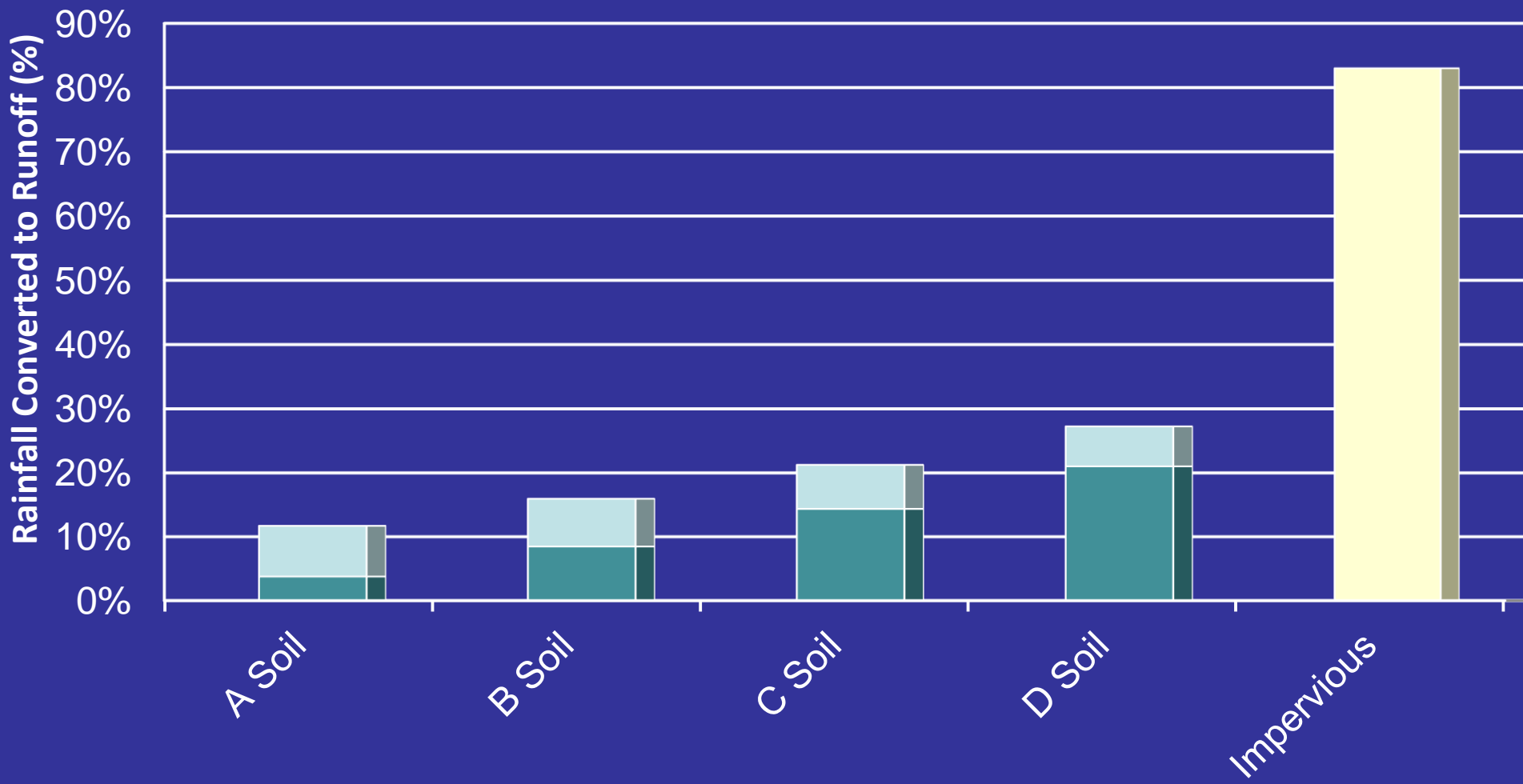
- **Required Volume controls**
 - **Control runoff for 95 percentile storm event (1.95 inch)**
- **Implementation**
 - **Step 1 New Developments - October 2009**
 - **Step 2 On-lot Controls – June 2010**
 - **Individual lot controls to 95th percentile**
 - **Can be exempted if development meets Step 1 requirements**

Integrating BMP Practice Runoff Reductions to EIC

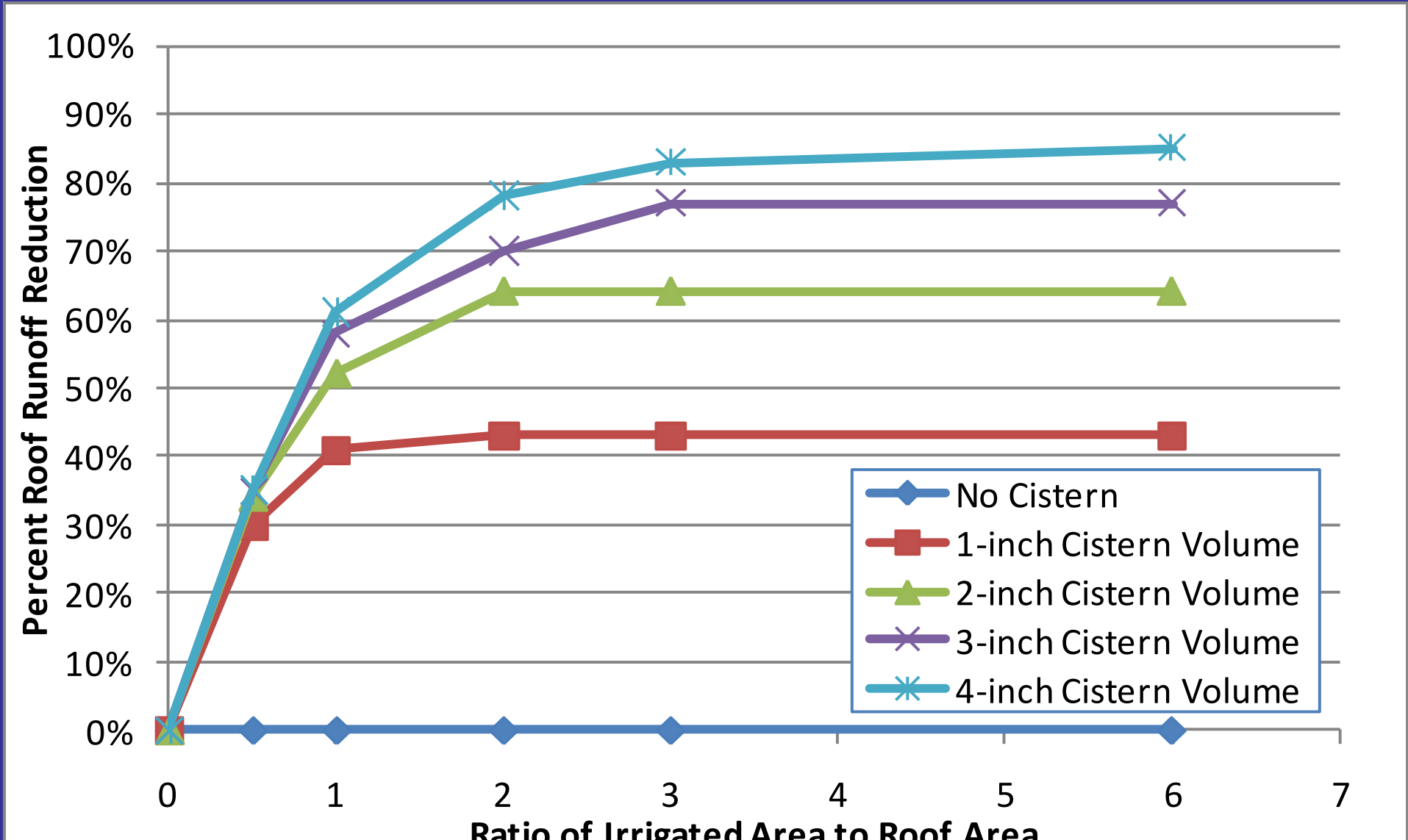
- **Integration Factors**
 - **Soil Type**
 - **Size of BMP**
- **Generate EIC for practice selected**
- **EIC reflects annual average Impact**
- **Annual average Impact can be related to WQ Control calculations**

Impervious Surface and Annual Runoff

■ Predevelopment Runoff ■ 100% Impervious ■ 10% Impervious Runoff



Capture for Reuse BMP Size Factor



EIC for Reuse with A Soils

Soil Group A					
Ratio Of	Effective Imperviousness for Various Combinations of				
Irrigated	Irrigated Area to Impervious Area Ratio and Captured Volume				
Area To	Captured Volume (inches)				
Impervious Area	0	1	2	3	4
0	100%	100%	100%	100%	100%
0.5	100%	69%	65%	64%	63%
1	100%	57%	46%	40%	36%
2	100%	55%	34%	24%	19%
3	100%	55%	33%	20%	13%
6	100%	55%	33%	19%	11%

EIC of Reuse with D Soils

Soil Group D					
Ratio Of	Effective Imperviousness for Various Combinations of				
Irrigated	Irrigated Area to Impervious Area Ratio and Captured Volume				
Area To	Captured Volume (inches)				
Impervious Area	0	1	2	3	4
0	100%	100%	100%	100%	100%
0.5	100%	62%	57%	56%	56%
1	100%	48%	34%	27%	23%
2	100%	46%	19%	8%	1%
3	100%	46%	18%	2%	-6%
6	100%	46%	18%	2%	-8%

Step 2 Requirements

- Required On-Lot Volume controls
 - Control runoff for 1.95 inch storm event
 - Options
 - BMP Manual – requires formal review
 - On-lot Volume worksheet – no technical review
 - Encourages Impervious Surface reduction to reduce size of volume practices
 - Options for staff variance if lot becomes unbuildable
 - Can be exempted if development complies

On-Lot Volume Worksheet

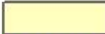



- Not only Method – but does not require technical review – field verification
- Uses three practices in series
 - Storage and Reuse
 - Disconnected Imperviousness
 - Raingardens
- Irrigation decisions impact practice requirements

Program Input - Homeowner

- Impervious Area
 - Rooftop
 - Other
- Total Lot Size
- Soil Type
- Irrigation Decision
- BMP Implementation Data

Figure 1
Two Runoff
Directions



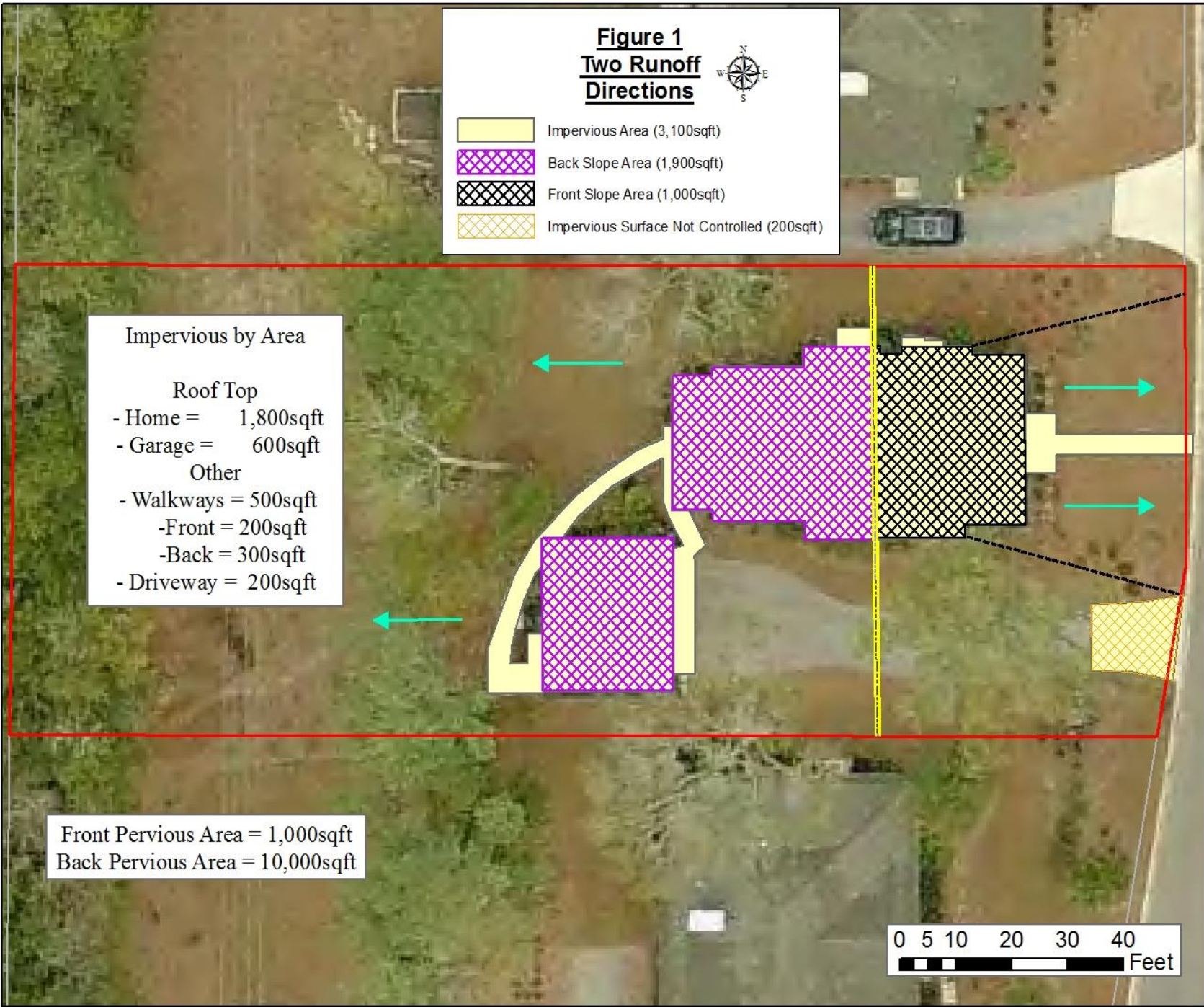
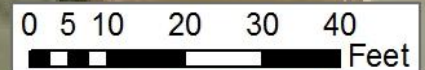
-  Impervious Area (3,100sqft)
-  Back Slope Area (1,900sqft)
-  Front Slope Area (1,000sqft)
-  Impervious Surface Not Controlled (200sqft)

Impervious by Area

Roof Top

- Home = 1,800sqft
 - Garage = 600sqft
- Other**
- Walkways = 500sqft
 - Front = 200sqft
 - Back = 300sqft
 - Driveway = 200sqft

Front Pervious Area = 1,000sqft
Back Pervious Area = 10,000sqft



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Projected Web Based Zoning Permit Attachment

Date: 3/6/2011

Builder/Homeowner Input

Address	Figure 1 Solution 1 Street
Parcel Number	R120
Home/Rooftop	2400 Square Feet
Other Impervious	700 Square Feet
Total Lot Size	16000 Square Feet
Soil Type	Sandy
Area to be Irrigated	5000 Square Feet

Excess Stormwater from Homeowner Input = 3565

Program Approved Practices

Storage and Reuse

Practice	Number	Size	Quantity
Rainbarrel	2	70	140
Cisterns	2	400	800

Disconnected Impervious Area

Practice	Impervious	Runoff Area	Quantity
First Runoff Direction	300	1000	336
Second Runoff Direction	1780	10000	1993.6

Raingarden

Size **36.7** Square Feet

Excess Stormwater controlled from practices = 3565 Gallons

What's next?

- While we have successfully created design standards to integrate water quantity and quality through site design and BMP construction, we haven't been as proactive with implementation
- What's the solution? MS4



Questions?



www.bcgov.net



Wasting away...

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(843) 592-1252
(502) 542-9731

