



# **Virginia Nutrient Design System for Updated Regulations & Handbook**

**TAC Meeting, 05/22/07**

**Center for Watershed  
Protection**

**Virginia Department of  
Conservation & Recreation**



# Background

- ◆ Technical Advisory Committee (TAC)
- ◆ Site-Based Performance Standards tied to Tributary Strategy Goals for Urban Land
- ◆ Update Handbook & Develop BMP Clearinghouse (VWRRC)

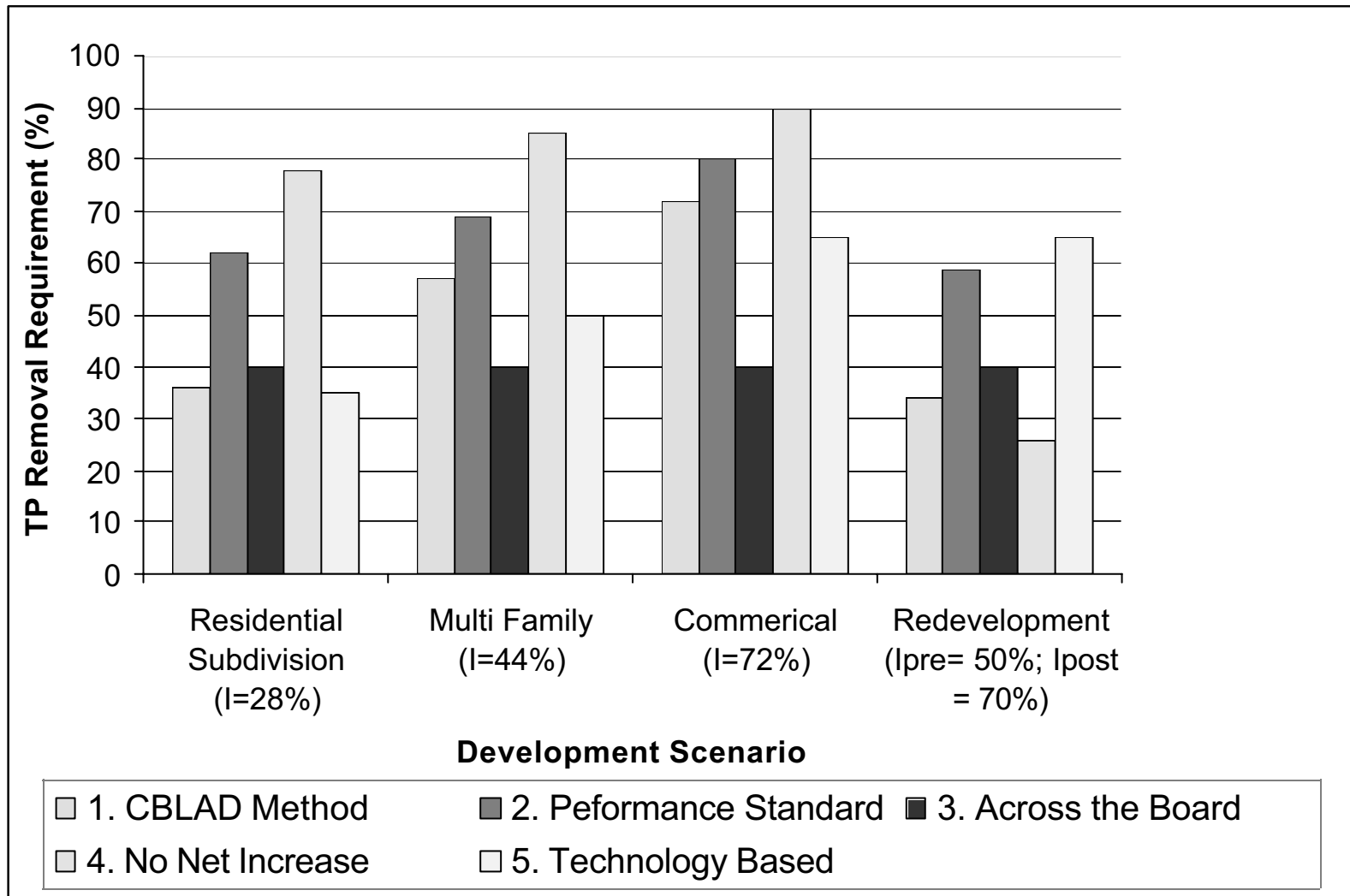
# CWP Role

- ◆ Look at basis for Urban Land Performance Goals
- ◆ Update Stormwater Quality & BMP Performance Data
- ◆ Develop Stormwater Quality Approach
  - Methods
  - Computations
  - Acceptable BMPs
  - Sample Plans
  - Fee-in-Lieu

# Review of Available Methods

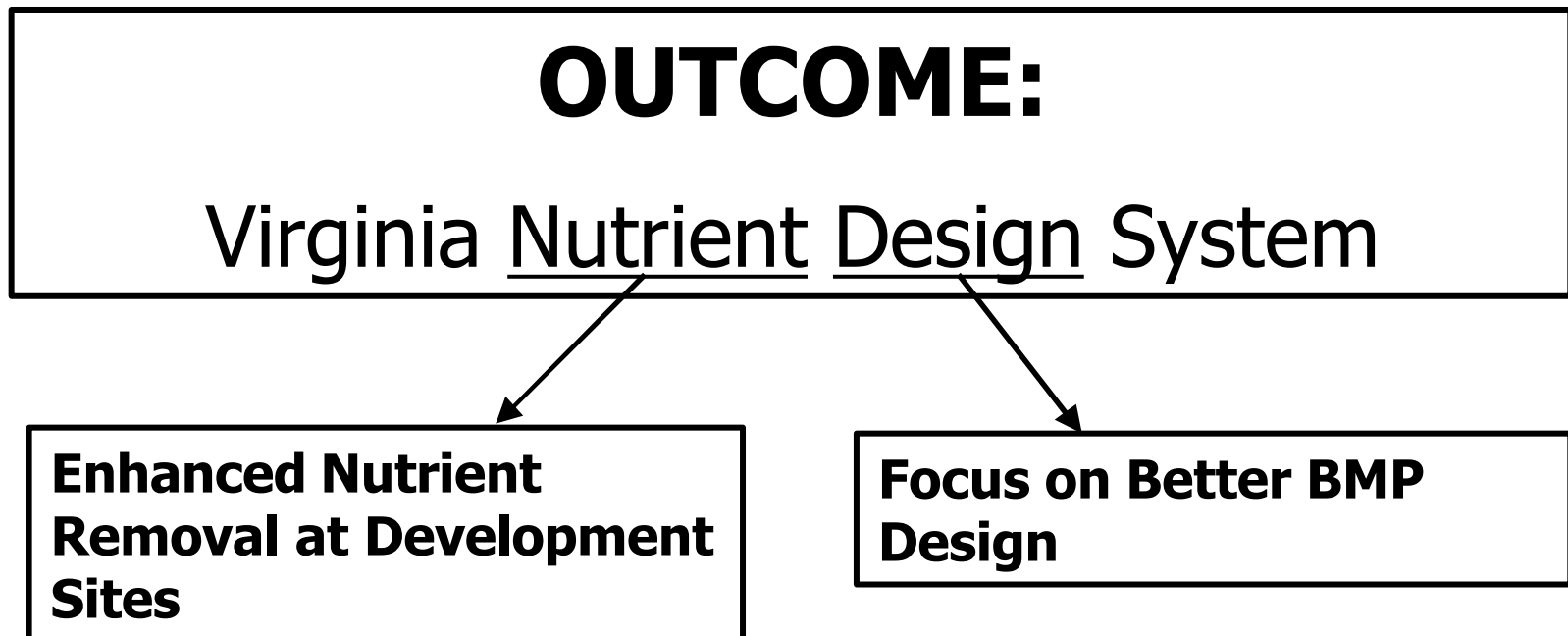
<b>1. CBLAD Method</b>	Reduce Load to Ave. Land Cover Condition
<b>2. Performance Standard</b>	Reduce Load to Site-Based Standard (e.g., 0.28 lbs/acre)
<b>3. Technology Approach</b>	Select from BMP Table (e.g., existing regs)
<b>4. No Net Increase</b>	Reduce Load to Pre-Development Levels
<b>5. One Size Fits All</b>	80% TSS, 40% TP

# Comparison of Methods



# Recommended Approach

- ◆ Performance Standards
- ◆ Technology Approach



**Accountability for Trib  
Strategies**

**Easy to Understand & Use**

**Achievable On-the-  
Ground Outcomes**

**Incorporates  
LID**

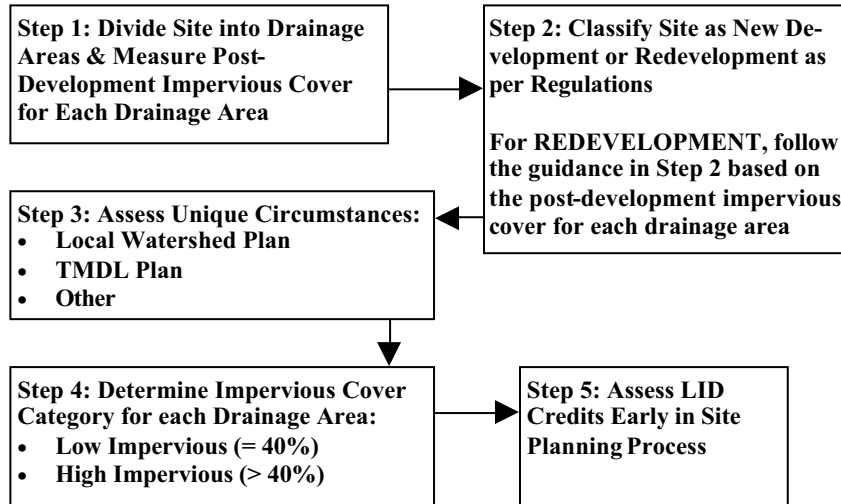
**Integrates With Other  
Standards**

# SECTION 1:

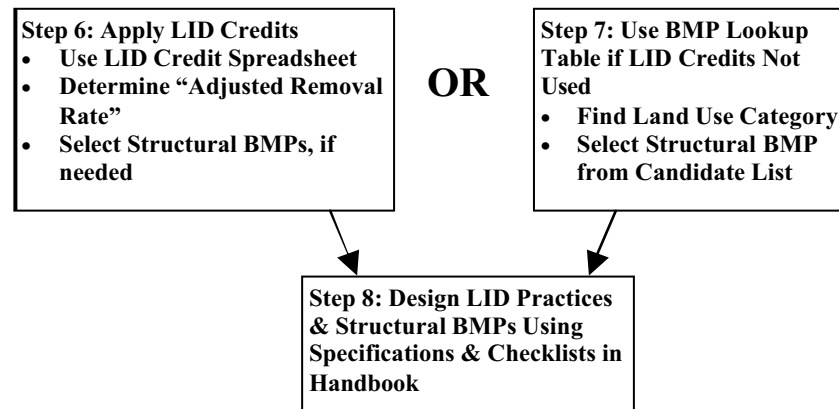
- ◆ Overall Method
- ◆ BMP Lookup Table
- ◆ 2 Levels of BMP Design

**Figure 1.1: Nutrient Design System Flowchart**

***PRELIMINARY ASSESSMENT***



***LID CREDITS & BMP LOOKUP TABLE:  
For Each Drainage Area: Proceed With Step 6 OR 7***



# Preliminary Assessment

- ◆ STEP 1 – Drainage Area is basis for WQ analysis
- ◆ STEP 2 – New Development or Redevelopment (cut off @ 40% impervious)\*
- ◆ STEP 3 – Unique Conditions (watershed plan)
- ◆ STEP 4 – Impervious Cover Category
- ◆ STEP 5 – Assess Low-Impact Development (LID) Credits EARLY in process!

**\* Redevelopment Criteria Are Provisional**

# LID Credits/BMP Lookup Table

- ◆ STEP 6 – LID Credit Spreadsheet, OR
- ◆ STEP 7 – BMP Lookup Table
- ◆ STEP 8 – Design Practices (Handbook & Clearinghouse)

# Site-Based Performance Standards

	<b>Total Phosphorus</b>	<b>Total Nitrogen</b>
<b>Low Impervious Sites (&lt; 40%)</b>	0.28 lbs/acre/yr	3.00 lbs/acre/yr
<b>High Impervious Sites (&gt; 40%)</b>	0.45 lbs/acre/yr	2.68 lbs/acre/yr

- Low Impervious – P is critical pollutant (yards, soil loss)
- High Impervious – N is critical pollutant (atmospheric deposition contribution to stormwater)
- BMP treatment mechanisms can be designed to treat both P & N

<b>Land Use Category &amp; Post-Development Impervious Cover Range</b>	<b>Post-Development Loads for Total Phosphorus (TP) &amp; Total Nitrogen (TN)</b>	<b>Pollutant Removal Rate (%RR) Required for TP &amp; TN</b>	<b>Candidate BMPs</b>
<b>HIGH IMPERVIOUS (&gt; 40%)</b>			
High Impervious # 1 I = 41 – 50%	TP = 1.01 lbs/acre/yr; TN = 4.91 lbs/acre/yr	TP = 55% TN = 45%	1. Bioretention#1 2. Infiltration #2 3. Wetland #2 4. WQ Swale #1 5. Filtering Practice
High Impervious # 2 I = 51 – 60%	TP = 1.19 lbs/acre/yr; TN = 5.80 lbs/acre/yr	TP = 60% TN = 55%	1. Bioretention#2 2. Infiltration #2 3. Wetland #2 4. WQ Swale #2 5. Filtering Practice
High Impervious # 3 I = 61 – 75%	TP = 1.46 lbs/acre/yr; TN = 7.12 lbs/acre/yr	TP = 70% TN = 60%	1. Bioretention#2 2. Infiltration #2 3. Wetland #2 4. Filtering Practice (Enhanced – expanded pre-treatment)
High Impervious # 4 I > 75%	TP = 1.74 lbs/acre/yr; TN = 8.45 lbs/acre/yr	TP = 75% TN = 70%	1. Bioretention#2 2. Infiltration #2 3. Filtering Practice (Enhanced – expanded pre-treatment)

# SECTION 2: LID Credits

- ◆ Description of Credits
- ◆ Spreadsheet

# LID Credits – Volume Reduction

1. Reforesting Riparian Area
2. Expanding/Protecting Riparian Area
3. Open Space Conservation
4. Open Space w/Hydrologic Function
5. On-Lot Practice
6. Rainwater Harvesting
7. Soil Amendments
8. Pervious Parking
9. Green Roof
10. Grass Channels
11. Other Impervious Disconnection



# LID Credit Spreadsheet – Site Information

LID Credits -- LOW IMPERVIOUS COVER (< 40%)		
<b>Project Name:</b>		
Woodbridge		
		cells in blue are data entry cells
		cells in yellow are calculated results
<b>Site Area (acres)</b>	23.82	
<b>Impervious (%)</b>	25	
<b>Impervious Area (acres)</b>	5.96	

# LID Credit Spreadsheet – Treated Area for Each Credit

Credit	Volume Reduction Credit (%)	Unit	Credit Area	I Reduction (ac)
1. Reforesting Riparian Area	50	acres reforested	0.3	0.15
2. Expanding/Protecting Riparian Area	50	acres expanded and/or protected	0.2	0.10
3. Open Space Conservation				
3.a. A/B Soils	75	acres conserved	0	0.00
3.b. C/D Soils	50	acres conserved	0.2	0.10

# LID Credit Spreadsheet – Adjusted Impervious Area & Adjusted BMP Removal

TOTAL CREDIT AREA
ADJUSTED IMPERVIOUS AREA
ADJUSTED IMPERVIOUS %

0.35
0.79
<b>37</b>

Parameter (post-development)		
<b>P</b>	Precipitation (in/yr)	43
<b>P<sub>j</sub></b>	Fraction of Runoff Producing Events	0.9
<b>I</b>	Adjusted Imperviousness Cover (%)	37
<b>R<sub>v</sub></b>	Runoff Coefficient	0.38
<b>C</b>	Mean Concentration of Pollutant (mg/L)	1.12
<b>A</b>	Area (acres)	1

<b>Post-Development Load (lb/yr):</b>	3.74
<b>Required Removal (2.68 N standard)</b>	1.06
<b>Adjusted BMP Efficiency Requirement</b>	<b>28%</b>

# LID Credit Spreadsheet – Select Structural BMP, If Needed

<b>BMP Type</b>	<b>Removal Efficiency for HIGH Impervious Cover Site (&gt; 40%)</b>
Wet Pond 1	30%
Wet Pond 2	40%
Bioretention 1	45%
Bioretention 2	55%
Infiltration 1	40%
Infiltration 2	65%
Constructed Wetland 1	25%
Constructed Wetland 2	55%
WQ Swale 1	45%
WQ Swale 2	55%
Filtering Practice	50%

# SECTION 3: Performance Calculation Method

**PCM STEP 2: Calculate Pollutant Removal Requirement**

$$RR_{TP} = L_{TP} - (S_{TP} \times A)$$

$$RR_{TN} = L_{TN} - (S_{TN} \times A)$$

Where:

$RR_{TP}$  = Total Phosphorus removal requirement (pounds/year)

$RR_{TN}$  = Total Nitrogen removal requirement (pounds/year)

$L_{TP}$  = Total Phosphorus post-development pollutant load (pounds/year) (Step 1)

$L_{TN}$  = Total Nitrogen post-development pollutant load (pounds/year) (Step 1)

$S_{TP}$  = Total Phosphorus performance standard (pounds/acre/year) (see below)

$S_{TN}$  = Total Nitrogen performance standard (pounds/acre/year) (see below)

$S$  values are as follows:

	$S_{TP}$	$S_{TN}$
<b>Low Impervious Sites (&lt; 40%)</b>	0.28 <i>lbs/acre/year</i>	3.00 <i>lbs/acre/year</i>
<b>High Impervious Sites (&gt; 40%)</b>	0.45 <i>Lbs/acre/year</i>	2.68 <i>Lbs/acre/year</i>

# SECTION 4: Example Specs & Checklist

	<b>Total Phosphorus %RR</b>	<b>Total Nitrogen %RR</b>
<b>Bioretention #1</b>	45%	45%
<b>Bioretention #2</b>	55%	55%

◆Sizing

◆Pre-Treatment

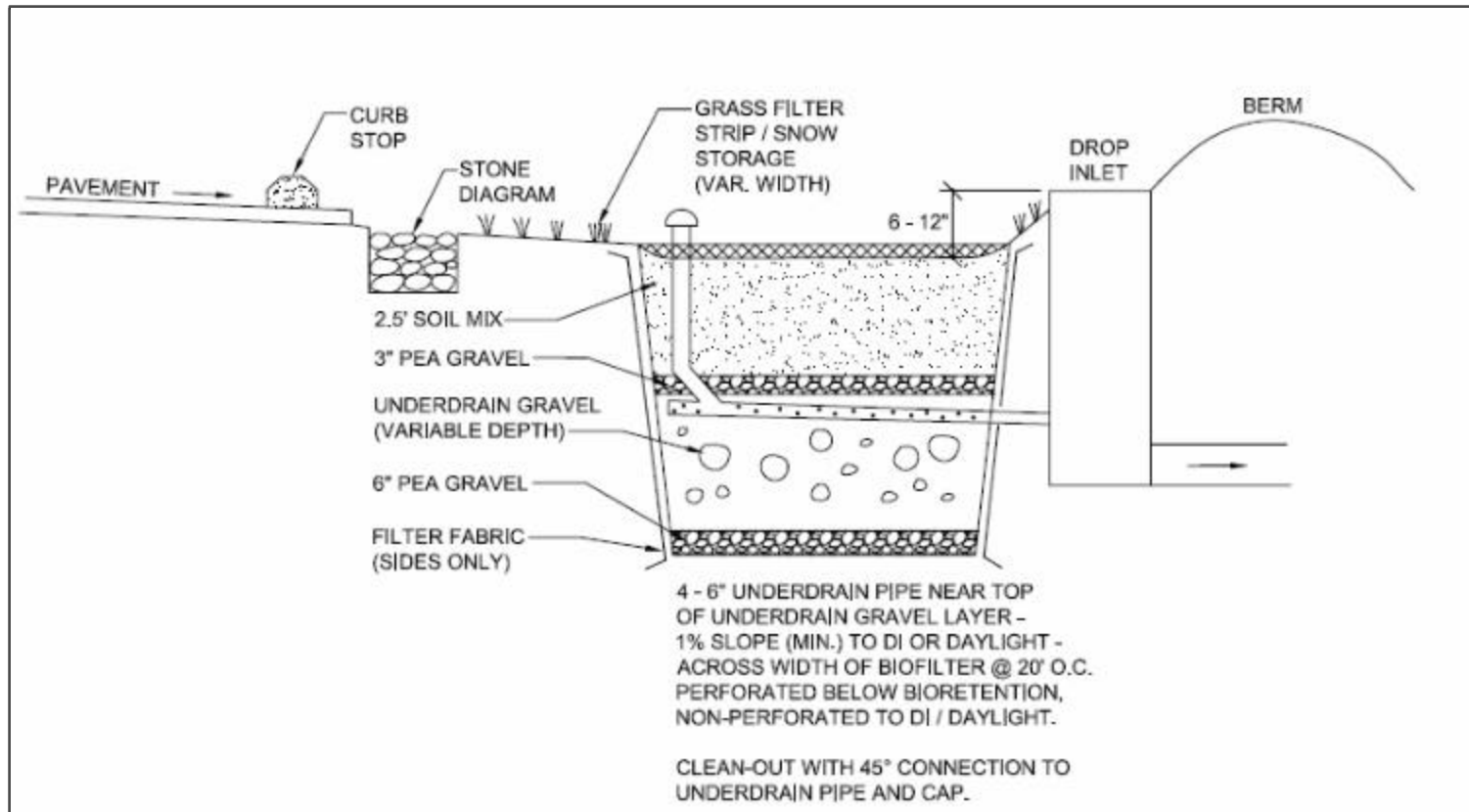
◆Depth of Media

◆Planting Plan

◆Infiltration

◆Off-Line

# Bioretention #2 – To be updated for Handbook and/or Clearinghouse



# Appendix A: Virginia Event Mean Concentrations (EMCs) from NSQD

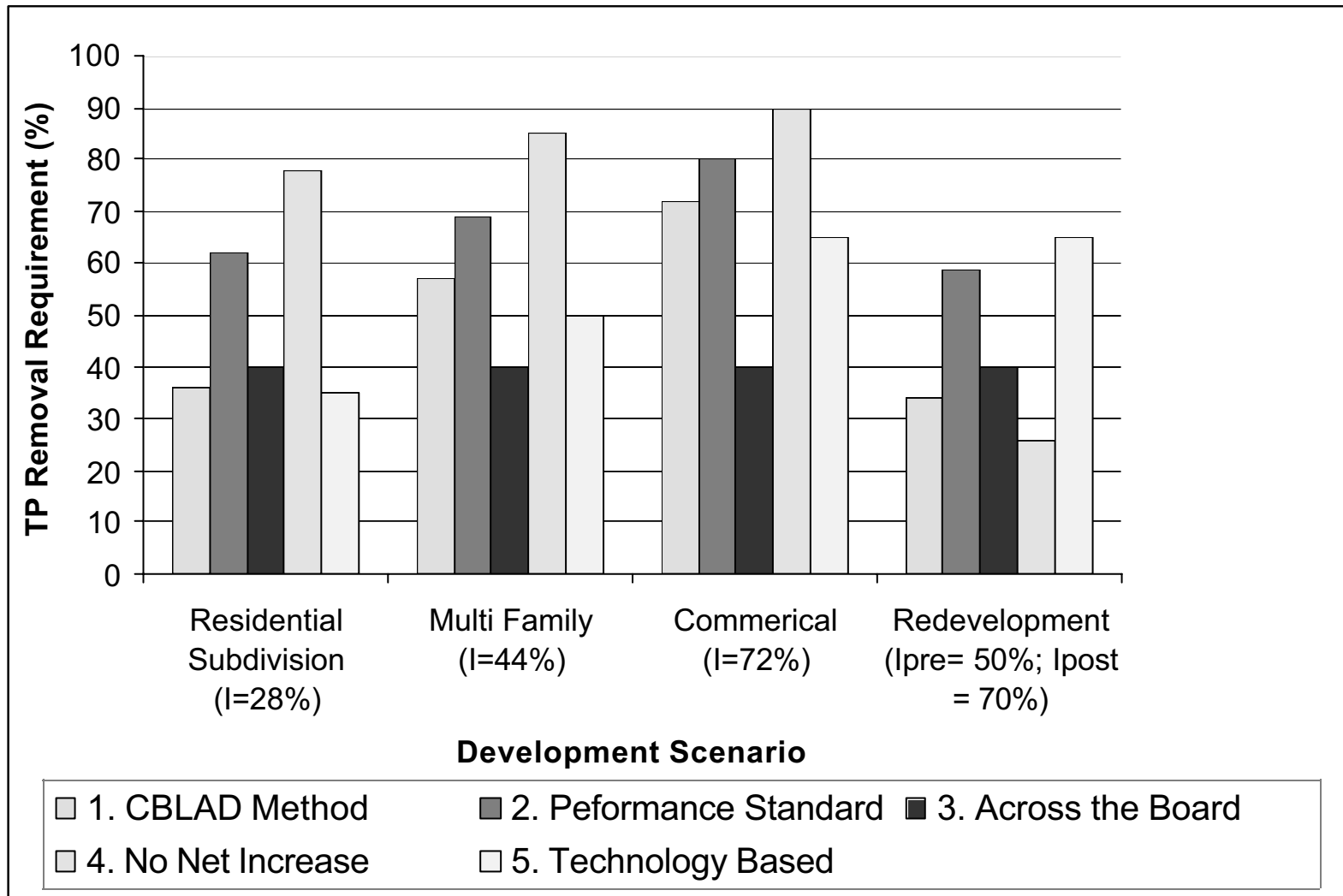
	<b>Virginia</b>	<b>National</b>
<b># Sites</b>	67	279
<b># Observations</b>	753	2834

Significant # of sites in NSQD from VA (almost 25%)

# Selected Virginia EMCs

	<b>Total Phosphorus</b>	<b>Total Nitrogen</b>
<b>Low Impervious Sites (&lt; 40%)</b>	0.28 mg/L	2.67 mg/L
<b>High Impervious Sites (&gt; 40%)</b>	0.23 mg/L	1.12 mg/L

# Appendix B: Available WQ Approaches



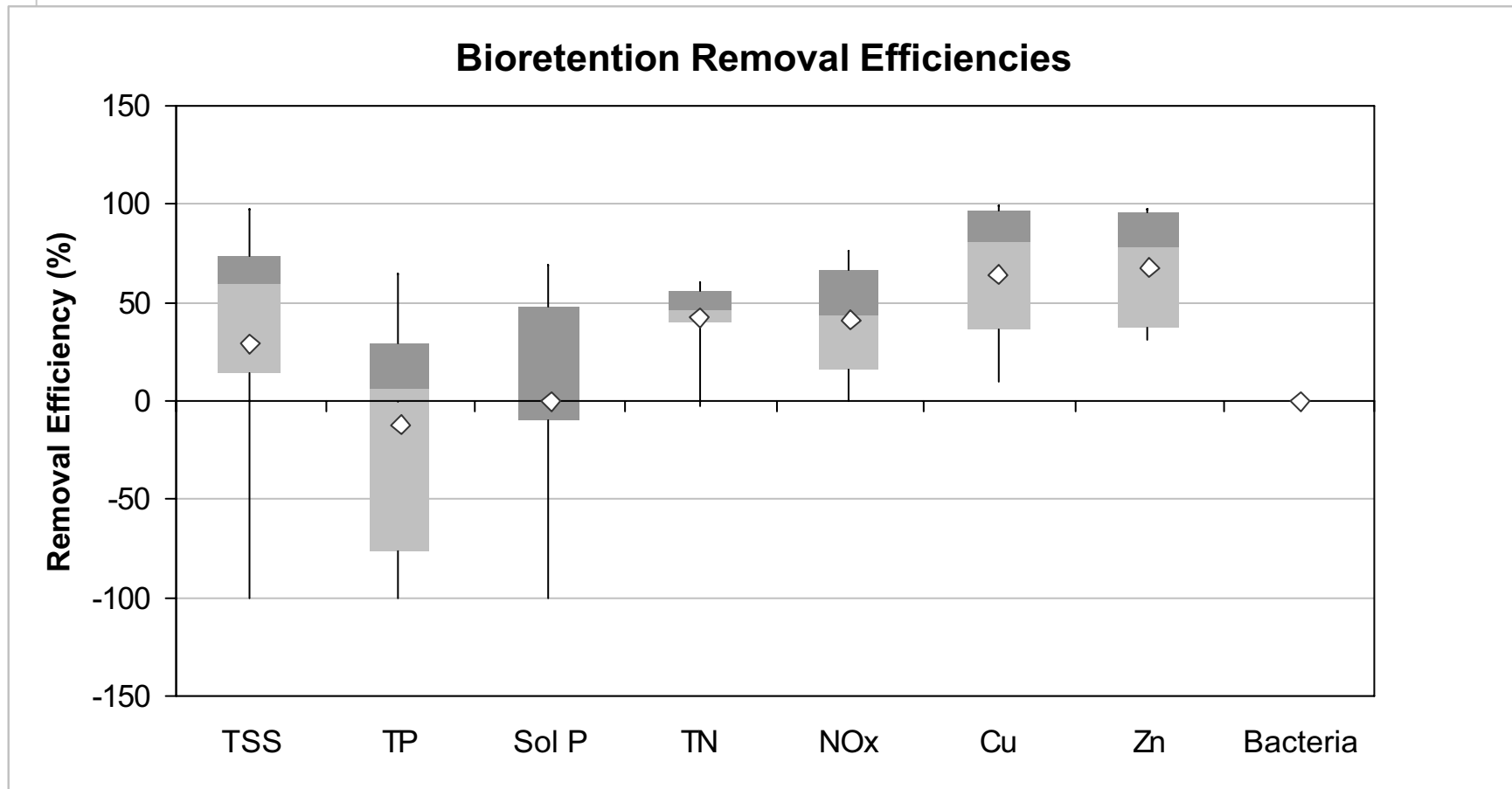
# Appendix C: BMP List for VA

- ◆ Evaluation of BMPs
- ◆ Acceptable BMPs for Virginia
- ◆ Irreducible Concentration
- ◆ Best Design Resources
- ◆ Updated BMP Performance Data from National Pollutant Removal Database

**Table 1. Recommendations for Acceptable BMPs**

BMP	Median Pollutant Removal Efficiency (%) (ranges in parantheses) (CWP, 2007)		Recommendation	VA Handbook Reference
	TP	TN		
Wet Pond (Retention Basin)	<b>52</b> (12-91)	<b>31</b> (-12-76)	Keep – provide 2 <sup>nd</sup> design option for enhanced pollutant removal	MS 3.06
Extended Detention	<b>20</b> (0-48)	<b>24</b> (-19-43)	Eliminate as stand-alone WQ treatment – poor pollutant removal performance	MS 3.07
Constructed Wetland	<b>48</b> (-55-100)	<b>24</b> (-49-76)	Keep - provide 2 <sup>nd</sup> design option for enhanced pollutant removal	MS 3.09

# Example: Box & Whisker Plot



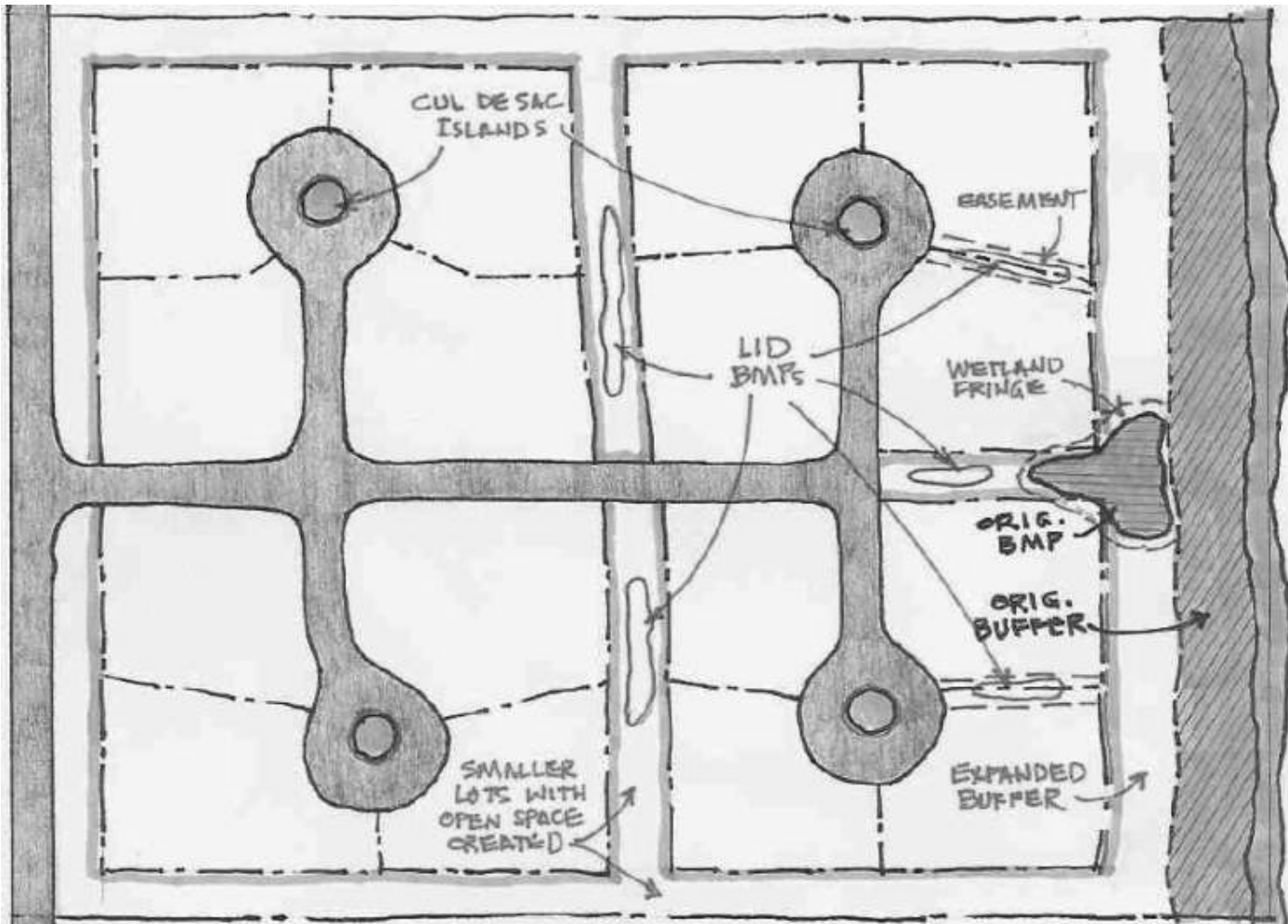
# LID Volume Reductions



## Recent Studies: Runoff Reduction (Ave. = 75%)

		<b>Runoff Reduction</b>
<b>Reference</b>	<b>Practice</b>	<b>(%)</b>
Dietz and Clausen, 2006	Bioretention	99
Van Seters et al., 2006	Bioretention	58
Rushton, 2002	Bioretention	98
Hunt et al., 2006	Bioretention	50
Smith and Hunt, 2006	Bioretention	40 - 60
UNHSC, 2006	Bioretention	75
Horner et al., 2003	Biofiltration Swale	98
Jefferies, 2004	Biofiltration Swale	94
Stagge, 2006	Biofiltration Swale	46 - 54
Rushton, 2002	Porous Pavement	75
Van Seters et al., 2006	Porous Pavement	99
Hunt and Lord, 2006	Porous Pavement	60 - 90
Jefferies, 2004	Porous Pavement	50
Coombes et al., 2004	Rainwater Harvesting	60 - 90

# Appendix E: Sample Plans



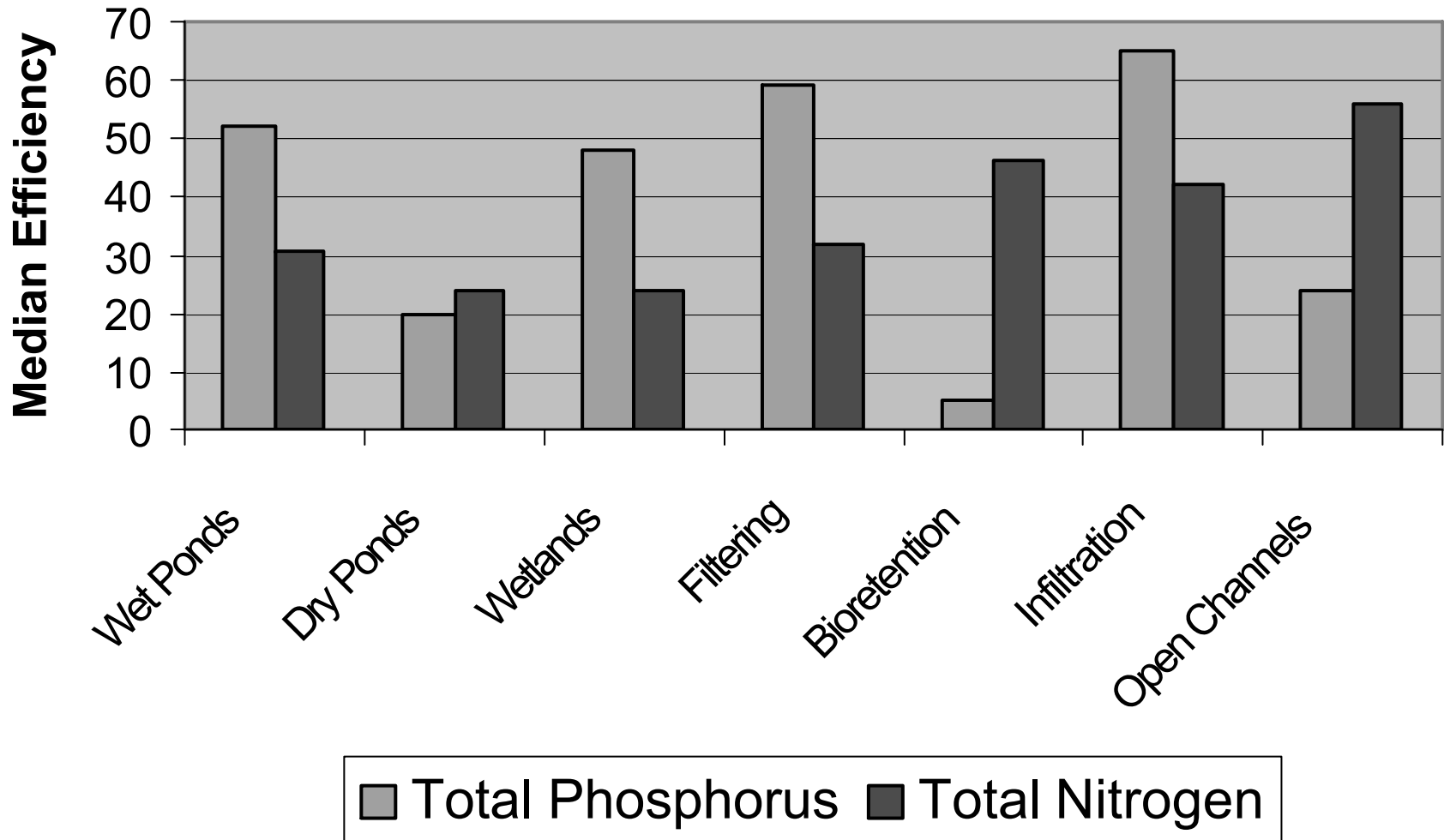
# Sample Plans

- ◆ Actual plans from VA localities
- ◆ Worked through Nutrient Design System process
- ◆ Retained existing layouts
- ◆ Mostly “modest” modifications to achieve compliance
- ◆ LID Credits are critical

# Conclusion – Virginia Nutrient Design System

- ◆ Performance Standards for Trib Strategy Urban Land Goals
- ◆ Easy-to-use BMP Lookup Table
- ◆ New & Improved LID Credits
- ◆ Two Levels of BMP Design
- ◆ Building Block for Regulations & Handbook

## Total Phosphorus & Total Nitrogen



# BMP Research: Beyond the Median

- ◆ Limited # of Observations for each BMP type
- ◆ Tremendous Spread in Some Cases
- ◆ Some BMPs Difficult to Monitor (e.g., Infiltration)
- ◆ Critical Factors
  - Flow Rate
  - Particle Sizes
  - Influent Concentration
- ◆ Accounting for Volume Reducing BMPs
- ◆ Different Treatment Processes

# Influent Concentration



# Influent Concentration

Performance Curve as a function of Influent Concentration

