Practical Applications of Stormwater BMPs for addressing Nutrient & Water Quality Challenges in Watersheds

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Florida Water Quality Challenges in 2016

Lake Okeechobee
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Port Mayaca Lock and Dam

St. Lucie River
Florida Nutrient Impairments:

- 691 Nutrient-Impaired Water Bodies
- 153 Nutrient-Based TMDLs
- > 10,000 mi²
Nutrient Sources

- Agriculture: Manure, Fertilizer, Soil Erosion
- Stormwater: Impervious surface runoff, Combined sewer overflows
- Wastewater: Treatment Plants, Legacy systems without nutrient removal controls, Septic Tanks
- Fossil Fuels: Power Plants, Industry, Transportation
- Homes: Fertilizers, Yard and pet waste, detergents
Where are Nutrients in the Environment?

Nutrient pollution causes low water quality in U.S. water bodies, including:

- > 100,000 miles of rivers and streams
- > 2.5 million acres of lakes and ponds
- > 800 square miles of bays and estuaries
Nutrient Control in a Watershed

Pollution Prevention

Source Control

On-Site Treatment

Receiving Water Treatment

Regional Stormwater Treatment
Best Management Practices
A Best Management Practice (BMP) is “…a practice or combination of practices considered…to be the most effective means (including technological, economic and institutional considerations) of preventing or reducing the amount of pollution by nonpoint sources to a level compatible with water quality goals.” 40 CFR 130.2

Non-Structural BMPs:
Prevent, control, treat pollutants before they enter the environment. Generally more cost effective than structural BMPs and can have a higher expectation of performance

Structural BMPs:
Constructed BMPs. Often based on mimicking natural systems and rely on water control, vegetation and soil mechanisms to perform as intended. Generally more expensive options than non-structural controls. Generally performs one of two functions: reducing the volume of stormwater discharge or reducing the volume of stormwater discharge or reducing concentrations of pollutants
Non-Structural BMPs

Street Sweeping

Educate Public

Disconnect / Reduce Impervious Area

Preserving Open Space

Smart Planning

Incorporating Natural Systems into Stormwater Management
Non Structural BMP
Disconnecting Impervious Area

High Runoff Volume Scenario
DCIA = 100%
NDCIA CN = 70
Non Structural BMP
Disconnecting Impervious Area

Lower Runoff Volume Scenario
DCIA = 60%
NDCIA CN = 70
37% less runoff = 37% Reduced Pollutants (i.e., Volume Control). Does not include concentration reduction if incorporating bioretention.
- Cost-effective source control
- Easily convert weight of street debris into mass of pollutants removed
- Accepted state practice for nutrient reduction
- Applicable to municipalities for NPDES permitting
- Applicable to developers for nutrient control.
Non Structural Control
Street Sweeping – Orange County, FL

Existing Program:
• 1,400 mile of swept roadways
• Roads swept every 6 weeks
• Roads swept every week

$1.9M Annual Cost
6 HIGH PRIORITY NEIGHBORHOODS IDENTIFIED TO INCREASE STREET SWEEPING.

Estimated Average Removal Costs:
$1,900/lb TN | $10,500/lb TP

(TMDL database for Florida BMPs, 2009)

Potential Increased Benefit of $19M
+28 tons P
+97 tons N
Structural BMPs

- Constructed BMPs: Often based on mimicking natural systems and rely on water control, vegetation and soil mechanisms to perform as intended. Generally more expensive options than non-structural controls.

Generally performs one of two functions: reducing the volume of stormwater discharge or reducing concentrations of pollutants. Examples include:

- Retention / Detention Ponds
- Bioretention
- Media Filters
- Porous Pavements
- RSC Systems
- Floating Wetlands
- Regenerative Stormwater Conveyance
- Floating Treatment Wetlands
- Real-Time Control Systems
- Stormwater Harvesting
Structural Controls

Bioretention Before

Porous Pavement Before
Active control systems increase detention time which increases pollution removal.
BMP Treatment Trains
It is frequently desirable that stormwater treatment systems be designed to include a combination of BMPs in series to achieve the required pollutant removal efficiency. This concept is called the “BMP Treatment Train”

- FDEP Draft Stormwater Quality Handbook
Regional Pond Strategy

Source: Titusville CRA Master Plan
BMP Treatment Trains

- **Regional Pond with BMP TT Strategy**
  - GI / LID → Treatment Train
  - Refined Hydrologic & Hydraulic Modeling

- Bioretention
- Planter Boxes
- Stormwater Harvesting
- Pervious Pavement
Groundwater Nutrient Control
“Stakeholders expressed concern during the BMAP process that the groundwater loads were not sufficiently accounted for in the modeling process.”
Conventional Understanding of Groundwater Seepage

**Layer 1 = Sand**

- $K = 5 \text{ ft/d}$, $V = K_i/n$, $V = 75 \text{ ft/yr}$

**Layer 2 = Clay**

- $K = 0 \text{ ft/d}$

To Lagoon
Tools for Enhancing Aquifer Understanding
Geoprobe® Hydraulic Profiling Tool

- Real-time profiles of soil hydraulic properties
- Rapid data collection
- Use in both saturated and unsaturated conditions
- Provides simultaneous log of electrical conductivity
- Downhole transducer measures pressure response of soil to injection of water (corresponds to K)
- Combine HPT results with discrete interval analytical data to understand flux

High K flow zone (plume transport)
Layer 1 = Silty Sand

Layer 2 = Sand w/ Shell

Layer 3 = Silt/Sand

Layer 4 = Shell w/ sand

Layer 5 = Silt

Layer 6 = Clay

To Lagoon

K = 1 ft/d

K = 35 ft/d, V=500 ft/yr

High K flow zone (plume transport)
BMP Effectiveness
Figure 23. Box Plots of Influent/Effluent Total Phosphorus Concentrations

| NDCIA | 0-15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|-------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| CN    |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 30    | 86.9 | 94.4| 89.4| 90.3| 89.7| 85.5| 83.1| 80.6| 78.2| 75.8| 73.6| 71.4| 69.3| 67.2| 65.3| 63.4| 61.6| 60.0|
| 35    | 94.8 | 93.3| 91.8| 89.5| 87.3| 86.0| 82.7| 80.3| 77.9| 75.8| 73.4| 71.2| 69.1| 67.1| 65.2| 63.4| 61.6| 60.0|
| 40    | 92.0 | 90.5| 89.2| 87.5| 86.8| 84.4| 82.1| 79.9| 77.6| 75.4| 73.2| 71.1| 69.0| 67.0| 65.2| 63.3| 61.6| 60.0|
| 45    | 89.0 | 88.2| 87.5| 86.6| 83.6| 81.5| 79.3| 77.2| 75.0| 72.9| 70.9| 68.8| 66.9| 65.5| 63.3| 61.6| 60.0|
| 50    | 86.6 | 86.6| 86.6| 86.2| 84.5| 82.7| 80.7| 78.7| 76.6| 74.8| 72.6| 70.6| 68.6| 66.6| 64.5| 62.5| 60.8| 60.0|
| 55    | 84.4 | 84.3| 85.7| 84.6| 83.2| 81.5| 79.8| 77.9| 75.9| 74.0| 72.1| 70.2| 68.4| 66.6| 64.8| 63.1| 61.5| 60.0|
| 60    | 83.9 | 83.9| 83.5| 82.7| 81.3| 79.1| 77.6| 76.8| 75.5| 74.2| 72.9| 71.5| 70.1| 68.6| 67.1| 65.6| 64.2| 62.7| 61.3| 60.0|
| 65    | 81.2 | 81.2| 81.0| 80.5| 79.4| 78.4| 77.2| 76.0| 75.7| 74.1| 72.5| 70.7| 69.3| 67.6| 66.0| 64.4| 62.9| 61.4| 60.0|
| 70    | 78.3 | 78.3| 78.3| 78.0| 77.4| 76.5| 75.5| 74.2| 72.9| 71.5| 70.1| 68.6| 67.1| 65.6| 64.2| 62.7| 61.3| 60.0|
| 75    | 75.3 | 75.3| 75.3| 75.2| 74.8| 74.2| 73.4| 72.5| 71.4| 70.3| 68.9| 67.5| 66.0| 64.5| 63.4| 62.2| 61.1| 60.0|
| 80    | 72.1 | 72.1| 72.1| 72.1| 72.0| 71.6| 71.1| 70.4| 69.6| 68.7| 68.1| 66.7| 65.6| 64.5| 63.4| 62.2| 61.1| 60.0|
| 85    | 69.9 | 69.9| 69.9| 69.9| 68.7| 68.4| 68.0| 67.5| 66.8| 65.4| 64.5| 63.7| 62.8| 61.8| 60.9| 60.0| 60.0| 60.0|
| 90    | 66.6 | 66.6| 66.6| 66.6| 65.6| 65.5| 65.2| 65.0| 64.6| 64.2| 63.7| 63.1| 62.6| 61.9| 61.3| 60.8| 60.0| 60.0|
| 95    | 63.3 | 63.3| 63.3| 63.3| 63.3| 63.3| 63.2| 62.1| 62.0| 61.8| 61.6| 61.4| 61.2| 60.9| 60.6| 60.0| 60.0| 60.0|
| 100   | 60.8 | 60.8| 60.8| 60.8| 60.8| 60.8| 60.8| 60.7| 60.7| 60.5| 60.6| 60.4| 60.3| 60.3| 60.2| 60.0| 60.0| 60.0|

56% Reduction

1. BMP Effectiveness
2. Florida and Nationally

60% Reduction
Thank you! Questions?

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