Water, Ion and Phosphorus Budgets of a Periphyton-Based Stormwater Treatment Area

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This Presentation Focuses on

- Description of PSTA
- Development and analysis of ion and nutrient budgets
- Improving accuracy of measurements
STA -3/4 is located 240 km SSE from Orlando.
PSTA cell is located on the south west corner of STA -3/4
This Periphyton-Based Stormwater Treatment Area is a Demonstration/Implementation Project

• What chemical, biological and design factors contribute to the ultra-low outflow TP levels?

• What loading rates and water depth achieve ultra-low outflow TP levels?

• What management practices sustain this performance?
PSTA Cell was Constructed by Scraping Peat to Caprock

Scraping material used to create vegetation strips that improved hydraulics and reduced wind effects on Submerged Aquatic Vegetation.

Peat removal reduced flux of P to water column and increased water contact with calcium caprock.
There are Two Inflow Gates and One Outflow Pump
Hydrologic Budgets Summarize Many Forms of Measured and Estimated Data

**Volume**

\[ y = 3.0389x^4 - 120.18x^3 + 1778.1x^2 - 11562x + 27795 \]
\[ R^2 = 1 \]

**Inflow/outflow**

\[ V_{t+1} = V_t + Q_{in,t} + Q_{seep,t} + R_t - E_t - Q_{out,t} \]

**Rain/Evaporation**

**Seepage**

\[ Q_{seep} = \Delta H \times \text{Levee length} \times 6.5 \]
By rearranging the equation the accuracy of the inflow and outflow measurements/estimates can be determined.

The error ranges from -52 to 90 ac-ft/day (average 2 ac-ft/day). The standard deviation is ±55 ac-ft or 24% of the average volume of 257 ac-ft.
Net Seepage is a Large Proportion of the Total Inflow to the PSTA Cell

Average turnover based on outflow is 15.5 days. Total Outflow exceeds inflow by 635 ac-ft/yr or 9.7%. Missing inflow?
Nutrient and Ion Budgets Rely Heavily on Hydrology

**Mass**

\[ M = V \times C \]

**Loads In and Out**

\[ L_{IN} = Q_{in} \times C_{in} \]
\[ L_{out} = Q_{out} \times C_{out} \]

**Atmospheric Deposition**

\[ L_{A} = \text{various methods} \]

**Seepage**

\[ L_{seep} = Q_{seep} \times C_{seep} \]

\[ M_{t+1} = M_{t} + L_{in,t} + L_{seep,t} + L_{A,t} - L_{out,t} \]
Chloride is a conservative tracer. The budget is similar to hydrologic budget.

Averaged turnover based on discharge is 12 days.

Discharge exceeds loads in by 64 metric tons per year or 8.2%.

Missing inflow?
Calcium Loads and Discharges are Nearly Equal

Averaged turnover based on discharge is 12 days.

Discharge exceeds measured loads by 17.5 metric tons/year or 3.3%

If some inflow is missing then PSTA cell may be removing some calcium
Sulfate is Being Removed Within the PSTA Cell

Total inflow concentration exceed outflow concentrations by 23% (10 mg/l)

Averaged turnover based on discharge is 14 days.

Measured loads in exceed discharge by 77 metric tons per year or 20%, of sulfate is being removed (biological uptake)
Phosphate is Being Removed Effectively Within the PSTA Cell

Total inflow concentration exceed outflow concentrations by 50% (9 µg/l)

Measured loads in exceed discharge by 73 Kilograms per year or 48% phosphorus is being removed through settling or biological uptake at an average removal rate of 181 mg/m²/year.
Improve Hydrologic Measurements by Reducing Pump Capacity

August 14, 2008 PSTA Cell

March 1, 2012
Improve Hydrologic Measurements by Reducing Cross Sectional Area of Inflow

Upstream view of inflow structure

Downstream view of inflow structure
Improve Seepage Inflow Measurements (Including Water Quality Sampling)
Enhanced Internal Water, Chemistry, Sediment and Plant Monitoring to Improve Understanding of How PSTA Works

Surface Water
- TP, TSP, SRP, DOC, UV absorbance, enzyme Alkaline phosphatase activity (APA) calcium, sulfate, NH₄-N, NOx, TKN,
- TP, TSP, SRP, DOC, UV absorbance
- Total P only
- Remote P analyzer

Vegetation and Sediment
- Monitoring for semi-quantitative SAV cover and floc depth
- Sediment, SAV and periphyton chemistry, SAV biomass, periphyton APA
- Periphymeter deployment

Hydraulic and hydrology
- Internal stage recorder
- Seepage water level
- Seepage water quality

(proposed): 4/24/2012
SUMMARY:
The PSTA cell is effective at removing phosphorus from the water column at low concentrations.

Outflow Phosphorus concentrations are at or below 10 µg/l between 70 and 80% of the time.

Less than 9% of the inflow samples are at or below 10 µg/l.
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QUESTIONS?

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