Advanced BMPs for Construction Site Erosion, Sediment, and Turbidity Control

Richard A. McLaughlin, Ph.D.
Associate Professor/Extension Specialist
Soil Science – NC State University

www.soil.ncsu.edu
Erosion: Start of the Problem
Erosion Prevention: First Line of Defense
Erosion Control: Can Polyacrylamide Help?
Rainfall Simulator: Ground Covers with/without PAM (20 lb/acre)
Field Tests: Turbidity – 1st Storm

Turbidity From 10/21/2002 Collection

Total rainfall: 1.35 inches

Turbidity (NTU)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BFM</td>
<td>Low</td>
</tr>
<tr>
<td>BFM+PAM</td>
<td>Very Low</td>
</tr>
<tr>
<td>Blanket</td>
<td>Low</td>
</tr>
<tr>
<td>Blanket+PAM</td>
<td>Low</td>
</tr>
<tr>
<td>Mulch</td>
<td>Low</td>
</tr>
<tr>
<td>Mulch+PAM</td>
<td>Low</td>
</tr>
<tr>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>None+PAM</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

NC STATE UNIVERSITY
DEPARTMENT of SOIL SCIENCE
Turbidity – 2nd Storm
Turbidity From 10/23/2002 Collection

Total rainfall: 0.4 inches
Turbidity – 3rd Storm

Turbidity From 10/30/2002 Collection

Total rainfall: 1.47 inches
Straw Enhanced by PAM

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Turbidity (NTU)</th>
<th>Erosion (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 dry</td>
<td>b</td>
<td>ab</td>
</tr>
<tr>
<td>33 wet</td>
<td>b</td>
<td>ab</td>
</tr>
<tr>
<td>66 dry</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>none</td>
<td>a</td>
<td>ab</td>
</tr>
</tbody>
</table>
Erosion Studies Conclusions

- Any ground cover is better than none (90% rule).
- Hydromulches and blankets may be more effective than straw.
Does PAM Reduce Erosion?

• PAM usually reduced erosion rates by 50% or more for typical ground covers.
• Straw + PAM (20 lb/ac or more) can outperform blankets and hydromulch.
Grade Control System Comparisons

- Rock Dam
- Georidge
- Triangular Silt Dike
- Linear (Triangular Silt Dike)

Sediment Retention (%)

Event 1

Event 2

Event 3
Check Dam Placement/Installation...
Maximum BMPs

Standard Checks/Traps

Coir/Straw Checks, PAM
Runoff Turbidity: 9/26/06

Sample #

Turbidity (NTU)

Red line: Standard BMPs
Blue line: Max BMPs

NC STATE UNIVERSITY
DEPARTMENT of SOIL SCIENCE
Wattle Theft!
Conventional BMP Impacts
Example of Construction Impacts on Streams

- Construction site greatly increases in-stream turbidity during storm events

Downstream: high turbidity from construction

Upstream: stable, no construction
Solutions: Build a Water Treatment Plant

...or
Other Approaches to Improvements

- Surface Outlets
- Baffles
- Infiltration
- Turbidity Reduction: Chemical Treatment (Polyacrylamide – PAM)
  - Passive: solid, liquid
  - Active: solid, liquid
Surface Outlet (Faircloth Skimmer)
Skimmer Basin Functions

• Skimmer backs up inflow to create pool
• Pool acts to slow flow and drop sediment
• Basin dewater primarily over emergency spillway!
• Skimmer dewater basin once inflow ceases.
  – Allows sediment to dry between storms
  – Reduces standing water (liability, mosquitoes)
Skimmer Basin Example

Skimmer

Spillway
Flashboard Riser Outlet

- Adjustable standing pool
- Can empty for sediment removal
- Could be used for stormwater wetlands etc.
- Doesn’t automatically dewater
- Could be left open…
Baffles

Porous

Silt Fence/Weir
No Baffles

- Free circulation, turbulence = poor settling
Silt Fence Baffles

- Reduced circulation, turbulence = better settling
Distributed Flow in a Porous Baffle Basin

• Entire cross-sectional area utilized
Porous Baffle Effects

- High turbulence in first cell, little in last
Measuring Baffle Effects
Effects of Baffles: Grain Capture

![Bar Chart]

Bar Chart showing the median grain size (μm) for different baffles configurations:
- Input: 134
- Free: 108
- Silt: 74
- Tree: 58
- Jute/Coir: 45

Baffle Configuration
Improvement from Surface Outlet/Porous Baffles

- May increase sediment capture from 60% to 90%.
- This will increase maintenance needs.
- Turbidity will still be an issue.
Chemical Treatment for Turbidity

- Polyacrylamide (PAM) is very common in water treatment, industrial processes.
- 1-2 mg/L will usually be the maximum required.
- Other chemicals: gypsum/alum (need high doses), chitosan (very expensive), inorganics (higher doses).
Flocs
Solid PAM Blocks
PAM Effects: Controlled Conditions

Graph showing the effects of PAM on turbidity over time for different outlets and conditions.

- Level spreader outlet
- Level spreader inlet
- Rock outlet
- Basin
- High flow
- PAM
Field Testing PAM Logs: Passive Treatment
Ditch Checks and Floc Log in Pipe
Riser Barrel – Great Log Location…
Two Chamber Basin Design
Keys to Making PAM Logs/Powder Work for You

• Match PAM to your soil or suspended sediment and water chemistry.
• Reduce sediment load prior to PAM treatment.
• Keep the PAM moist.
• Create high flow onto PAM.
• Create high mixing (turbulence) after PAM.
• Allow for settling post-treatment.
Active PAM Dosing
Turbidity Reductions in Liquid Dosing Tests

- Stilling Basin Outlet
- Sed. Bag Outlet

No PAM
- Jute/coir Baffles
- No Baffles

PAM 1
- Jute/coir Baffles
- No Baffles

PAM 2
- Jute/coir Baffles
- No Baffles
Pump Into Pipe w/ Solid PAM
PAM Toxicity?

- PAM is known to be relatively non-toxic as measured by acute (LD$_{50}$) tests.
- Chronic tests on fish also show low toxicity.
- Chronic tests on smaller species unknown.
Effluent Test: Ceriodaphnia dubia
7-day chronic reproduction
Ceriodaphnia dubia Tests

- Conducted by DENR-DWQ-Aquatic Toxicology Unit or approved lab.
- Used PAM solutions replaced daily.
- Measured mortality and reproduction rates after 7 days.
- No acute toxicity apparent
- Chronic toxicity (7 day reproduction) effects >3-5 mg/L, the maximum expected dose for turbidity.
North Carolina PAM List

- Approved for use in dosing turbid water.
- Requires a settling basin or sediment bag after dosing.

- **Company/Product/Maximum Application Concentration (ppm)**
  - Applied Polymer Systems APS 705 27.7
  - Applied Polymer Systems APS 712 59.3
  - Applied Polymer Systems APS 730 5.6
  - Applied Polymer Systems APS 740 5.2

  - Also 3 solid blocks are approved

- [http://h2o.enr.state.nc.us/ws/documents/pams_list.pdf](http://h2o.enr.state.nc.us/ws/documents/pams_list.pdf)
Sediment and Turbidity Technology Summary

- Sediment basins and traps can be optimized to capture much more sediment than with current designs.
- Turbidity escapes most physical traps.
- Reducing turbidity with chemical treatment requires a post-dosing capture system (basin, filter bag).
- PAM is cost-effective when systems work.
- Continued study of PAM dosing systems under "real" conditions is needed.
- PAM does not appear to have significant environmental toxicity.
Questions?