Research Results to Keep You Out of Trouble

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Water Quality is Important
Three Key Areas

- Erosion: Keeping soil in place, vegetation establishment
- Sediment: Keeping sediment on site
- Turbidity: Reducing impacts of runoff on surface waters
Ground Covers: Construction Site, Field, and Rainfall Simulator Testing
Controlling Erosion: Can Polyacrylamide Help?
Results: Need ground cover, more PAM

- No Straw
- Straw
Rainfall Simulator: PAM (20 lb/acre) Reduces Turbidity for Most Groundcovers
More Mulch/PAM Tests
### PAM Effects by Cover: Usually Large Turbidity Reduction

<table>
<thead>
<tr>
<th>Cover</th>
<th>Sites</th>
<th>Erosion Rate Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw</td>
<td>3</td>
<td>45-78%</td>
</tr>
<tr>
<td>Excelsior</td>
<td>2</td>
<td>51-69%</td>
</tr>
<tr>
<td>Wood Hydro</td>
<td>1</td>
<td>98%</td>
</tr>
<tr>
<td>Flexterra</td>
<td>1</td>
<td>20%</td>
</tr>
</tbody>
</table>
Straw vs Straw+PAM vs Hydromulches (5)
## Final Results: Erosion

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Site 1, Kinston</th>
<th>Site 2, West Jefferson</th>
<th>Site 3, Garner</th>
<th>Site 4, Apex</th>
<th>Site 5, Holly Springs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw</td>
<td>3,685a</td>
<td>51bc</td>
<td>36b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw+PAM</td>
<td>1,261ab</td>
<td>29c</td>
<td>29b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMM</td>
<td>959bc</td>
<td>N/A</td>
<td>35b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BFM</td>
<td>1,930ab</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FGM</td>
<td>333c</td>
<td>164ab</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WFM</td>
<td>N/A</td>
<td>237a</td>
<td>120ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WCB</td>
<td>N/A</td>
<td>221ab</td>
<td>210a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PAM=Polyacrylamide. FGM=flexible growth media. SMM=stabilized mulch matrix. BFM=bonded fiber matrix. WFM=wood fiber mulch. WCB=70:30 wood fiber/cellulose blend.
Summary of Ground Cover Studies

- Not much difference between mulches (straw is fine) for erosion or grass growth
- Applying polyacrylamide reduces erosion
- Weather makes or breaks your grass establishment, especially rainfall patterns. *Supplemental watering recommended!*
Using Polyacrylamide (PAM) to Reduce Erosion on Construction Sites

Introduction

Sediment and turbidity have the widest impact on water quality of any pollutants. Runoff from sites where bare soil is exposed, such as construction sites or tilled farm fields, often carries high sediment loads into receiving water bodies where some of the sediment settles, filling channels and lakes and causing habitat destruction. One approach to reducing this type of erosion is to use chemical treatments to augment seeding and mulching. The chemical polyacrylamide (PAM) is well suited for erosion control enhancement, and its use is described below.

Characteristics of PAM

PAM is a term describing a wide variety of chemicals based on the acrylamide and acrylate units. When linked in long chains, these units can be modified to result in a net positive, neutral, or negative charge on the PAM molecule. The positively charged, or cationic, PAMs, are not used for erosion control because they can be toxic to fish and other aquatic organisms if they spill into water bodies in sufficient concentrations. The negatively charged, or anionic, PAMs, are much less toxic to aquatic organisms and are widely used in furrow irrigation agriculture. This type of PAM is the focus of this discussion, and all references to “PAM” are to the anionic forms.

Related Publications

- Chemical Treatment to Control Turbidity on Construction Sites
- Fiber Check Dams and Polyacrylamide for Water Quality Improvement
- Water Quality and Turfgrass Area Development
- Options for Backyard Stream Repair
- Best Management Practices for Agricultural Nutrients

Browse SoilFacts
We’ve Got a Sediment Problem!
Typical Samples from Construction Site

40% Solids!
Channel Grade Control: Prevent Ditch Erosion

Rock Dam

GeoRidge

Ditches are often the largest source of sediment on construction sites!
Less Porous = Better Grade Control
(sediment retention as indicator)
What About Those Sediment Basins?

Old Way: Dig hole, rock pile at outlet

Time to do some design testing...
Rock Outlet: 50% Capture, No turbidity change
Surface Skimmer Outlet: Higher Sediment Capture, Lower Turbidity

![Image of surface skimmer outlet with graph showing turbidity decline over time. The graph compares turbidity levels in the basin and at the outlet, with the outlet showing significantly lower turbidity levels throughout the time period.]
Can We Improve Basin Further: Baffle Testing
Effects of Baffles: Grain Capture Increase

- Input
- Open
- Silt Fence
- Highly Porous
- Current (Coir)

Grain Size at Outlet
Surface Outlet + Porous Baffles = >90% Capture
Finally: The Optimized Sediment Basin!
Standing Pool: Many Benefits

- Keeps skimmer off bottom
- Settles first flush
- Retains “dirtiest” water
- Mosquito issues not likely
Turbidity Still a Problem...

Skimmer Outlet
Basin Design Effects with Flocculants
Dosing System: Solution vs. Solid Block

The diagram shows the turbidity reduction (%) in different conditions:
- **Without** and **With** Baffles
- **No PAM**
- **Anionic PAM Solution**
- **Floc Log**

The comparison indicates that the presence of PAM and floc logs significantly reduces turbidity, with the Anionic PAM Solution providing the highest reduction.
Sediment Bags and Flocculants
Can We Improve Effectiveness?
Sediment Bag and PAM

**Graph Description:**
- **Y-axis:** Turbidity (NTU)
- **X-axis:** Time
- **Graph Types:**
  - Source Pond
  - Sediment Bag Alone
  - Sediment Bag + PAM

**Key Observations:**
- Source Pond shows a decreasing trend in turbidity over time.
- Sediment Bag Alone also shows a decrease but with fluctuations.
- Sediment Bag + PAM has the lowest turbidity and shows the most consistent trend with the least fluctuations.

**Legend:**
- Source Pond
- Sediment Bag Alone
- Sediment Bag + PAM

**Note:**
Sediment Bag + PAM was injected at the pump intake.
Testing Flocculation Methods

Water source (900 m³)

Soil addition

Jute matting

Wattle

Sampling location

Wattle with jute matting

Wattle without jute matting

PAM on the weir of wattle

PAM on jute matting

Flocculant Added
Results: Turbidity Reduction Regardless of Introduction Method

Different letters within an event indicates statistically significant differences.
DOT Multi-Chamber Basin to Capture Sediment and Reduce Turbidity

- **Upper Chamber:** Sediment Capture
- **Overflow to 2nd Chamber**
- **Place Flocculant Here**
- **Lower Chamber:** Turbidity Reduction
Installed Turbidity Control
Baffles/Skimmer + Flocculation

- Turbidity reduced 50-90%
- May not achieve regulatory goals (50 NTU), but much better than no flocculation.
- Reduced complaints and impacts.
Successful Construction Site Water Quality Management

- Groundcovers reduce erosion by 90%, PAM will also reduce turbidity in runoff
- Sediment basins with stable inlets and sides, porous baffles, and surface outlets will capture 99% of sediment
- Turbidity can be controlled with proper introduction of flocculants in water conveyance systems
Can we use our developed landscapes for stormwater control?
Without resorting to expensive engineered approaches?
CONTROLLED PLOT TEST ON COMPACTED SOIL

**Design:**
Randomized split complete block design with four reps

**Main plots:**
1. Control (C: compacted)
2. Shallow tilled (ST; 15 cm)
3. Shallow tilled+ Lime
4. Deep tilled (DT; 30 cm)
5. Deep tilled+ Lime

**Sub plots:**
1. Mowed (M)
2. Not mowed

- Fertilizer recommended by North Carolina Department of Agriculture
- North Carolina Department of Transportation recommended mixed seed rate of Hard Fescue, Kentucky Bluegrass and Rye Grass.
Retrofits on Roadsides
Compost Effect at Three Sites: Infiltration

![Bar chart showing infiltration rates at Coastal Plain, Piedmont, and Mountain sites with and without compost.](chart.png)

- **Coastal Plain**
  - Without compost: 32.6 cm h⁻¹
  - With compost: 40.0 cm h⁻¹

- **Piedmont**
  - Without compost: 22.4 cm h⁻¹
  - With compost: 44.6 cm h⁻¹

- **Mountain**
  - Without compost: 47.9 cm h⁻¹
  - With compost: 88.4 cm h⁻¹

40 cm = 16 inches
## Vegetation Effect: Infiltration (cm/hr)

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>Coastal Plain</th>
<th>Piedmont</th>
<th>Mountain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>26.5b</td>
<td>24.8b</td>
<td>56.3b</td>
</tr>
<tr>
<td>Wildflowers</td>
<td>46.6a</td>
<td>42.3a</td>
<td>80.0a</td>
</tr>
</tbody>
</table>

40 cm = 16 inches
Wildflower plots were mowed only 1 time each year, grass plots 4X. Less mowing = $$$ saving
Conclusions So Far

- Tillage can greatly enhance infiltration in compacted soils, less effective in long-established grass.
- The effect is long-lasting (we measured up to 3 years) as long as vegetation is vigorous and traffic minimized.
- Compost, at the rate tested, often improved upon the tillage effect and may provide some resilience.
- Further testing of compost rate effects is underway.
Unmanned Aerial Vehicles for Construction Site Management

- UAV-based aerial surveys using **Mavic Pro Platinum** and **Phantom 4 RTK** UAVs.
- Can they be used for inspections?
- Can they produce surveys for topographic analyses?
Flow Modeling

- Each color is a “watershed”
- Outlets to basins or silt fence outlet
• Breach in berm
## Watershed for Each Silt Fence Outlet

<table>
<thead>
<tr>
<th>Sediment Fence (ha)</th>
<th>1 *(0.2)</th>
<th>2 *(0.2)</th>
<th>3 *(0.2)</th>
<th>4 *(0.1)</th>
<th>5 *(0.1)</th>
<th>6 *(0.3)</th>
<th>7 *(0.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>59</td>
<td>55</td>
<td>58</td>
<td>41</td>
<td>41</td>
<td>83</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Estimated Acreage (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.28.20</td>
<td>0.08 0.3 0.7 0.3 0.01 0.3 0.0</td>
</tr>
<tr>
<td>03.09.20</td>
<td>0.08 0.3 0.8 0.1 0.00 0.6 0.0</td>
</tr>
<tr>
<td>03.16.20</td>
<td>0.2 0.3 0.4 0.3 0.04 0.8 0.0</td>
</tr>
<tr>
<td>03.23.20</td>
<td>0.2 0.3 0.3 0.4 0.0 0.6 0.0</td>
</tr>
<tr>
<td>06.12.20</td>
<td>0.2 0.3 0.01 0.02 0.07 0.08 0.0</td>
</tr>
</tbody>
</table>
## Estimated Excavation from Topography

<table>
<thead>
<tr>
<th>Date (Timeframe)</th>
<th>UAV Estimates</th>
<th>NCDOT Estimates (truck count)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net Changes (m³)</td>
<td></td>
</tr>
<tr>
<td><strong>Excavation</strong></td>
<td>(597)</td>
<td>(434)</td>
</tr>
<tr>
<td><strong>Excavation</strong></td>
<td>6390</td>
<td>4644</td>
</tr>
<tr>
<td>01.28-20-03.09.20</td>
<td>5485</td>
<td>6028</td>
</tr>
<tr>
<td>03.09.20-03.16.20</td>
<td>980</td>
<td>719</td>
</tr>
<tr>
<td>03.16.20-03.23.20</td>
<td>27046</td>
<td>22064</td>
</tr>
<tr>
<td>03.23.20-06.12.20</td>
<td>39901</td>
<td>33455</td>
</tr>
<tr>
<td><strong>Total Sum</strong></td>
<td>(3728)</td>
<td>(3125)</td>
</tr>
</tbody>
</table>
Weekly Inspections

UAV Advantages

- Can work around traffic and equipment safely
- No issues with getting stuck in the mud
- Have a photographic record
- May be faster?
- Silt fences may be a problem
Questions?

Based on all the head tilts, maybe I'd better explain this again...