# Treatment Using PAM with Hard and Soft Armoring

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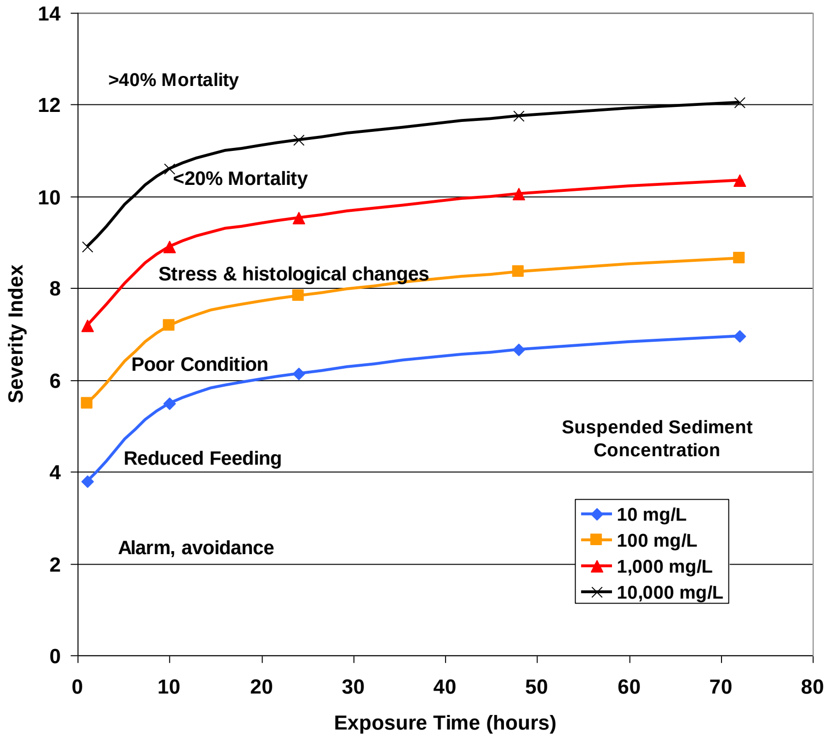
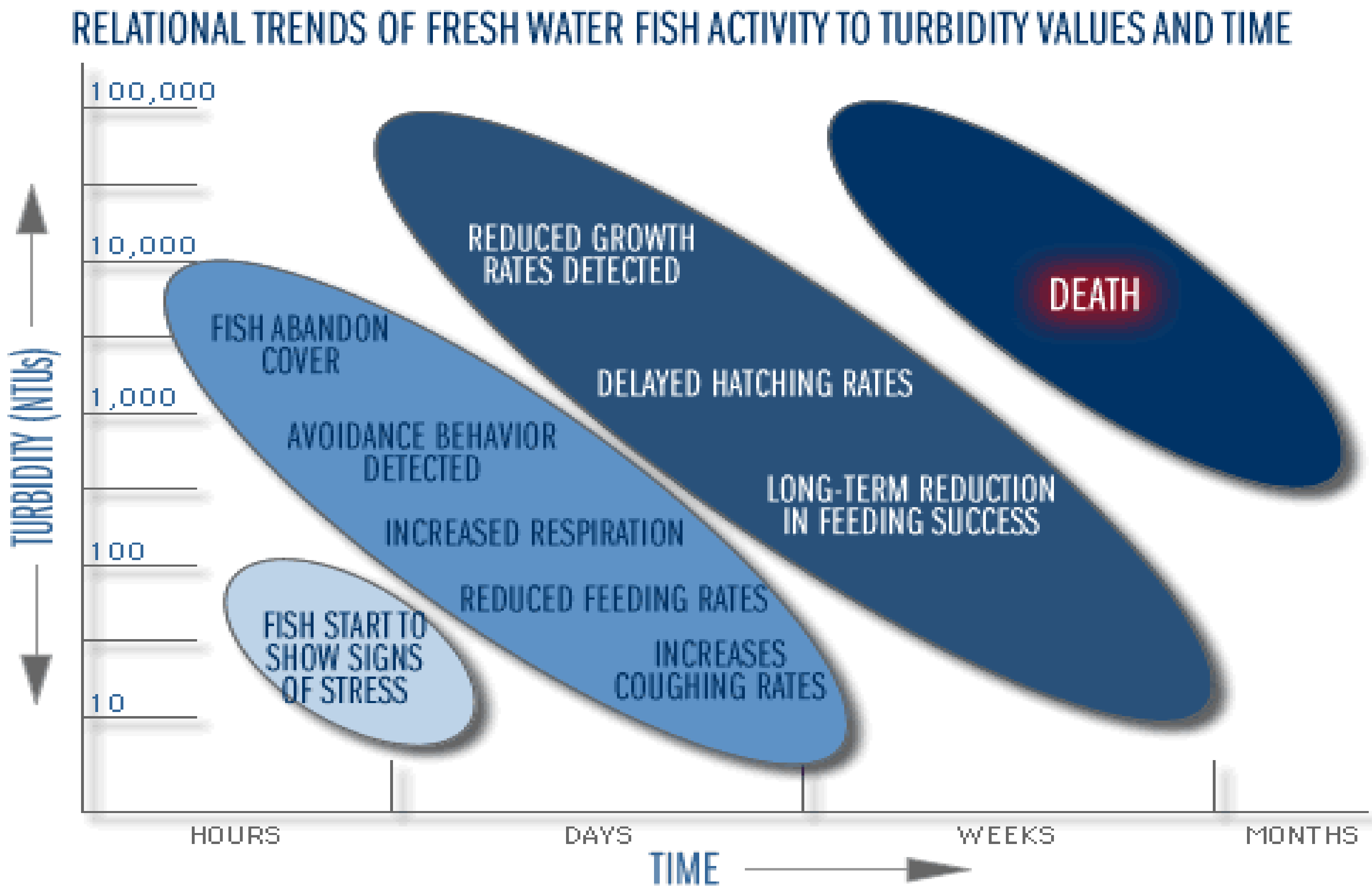
**Applied Polymer Systems, Inc.**

# Suspended Sediment Effects
## Newcombe & McDonald, 1991

- Review of 120 Studies

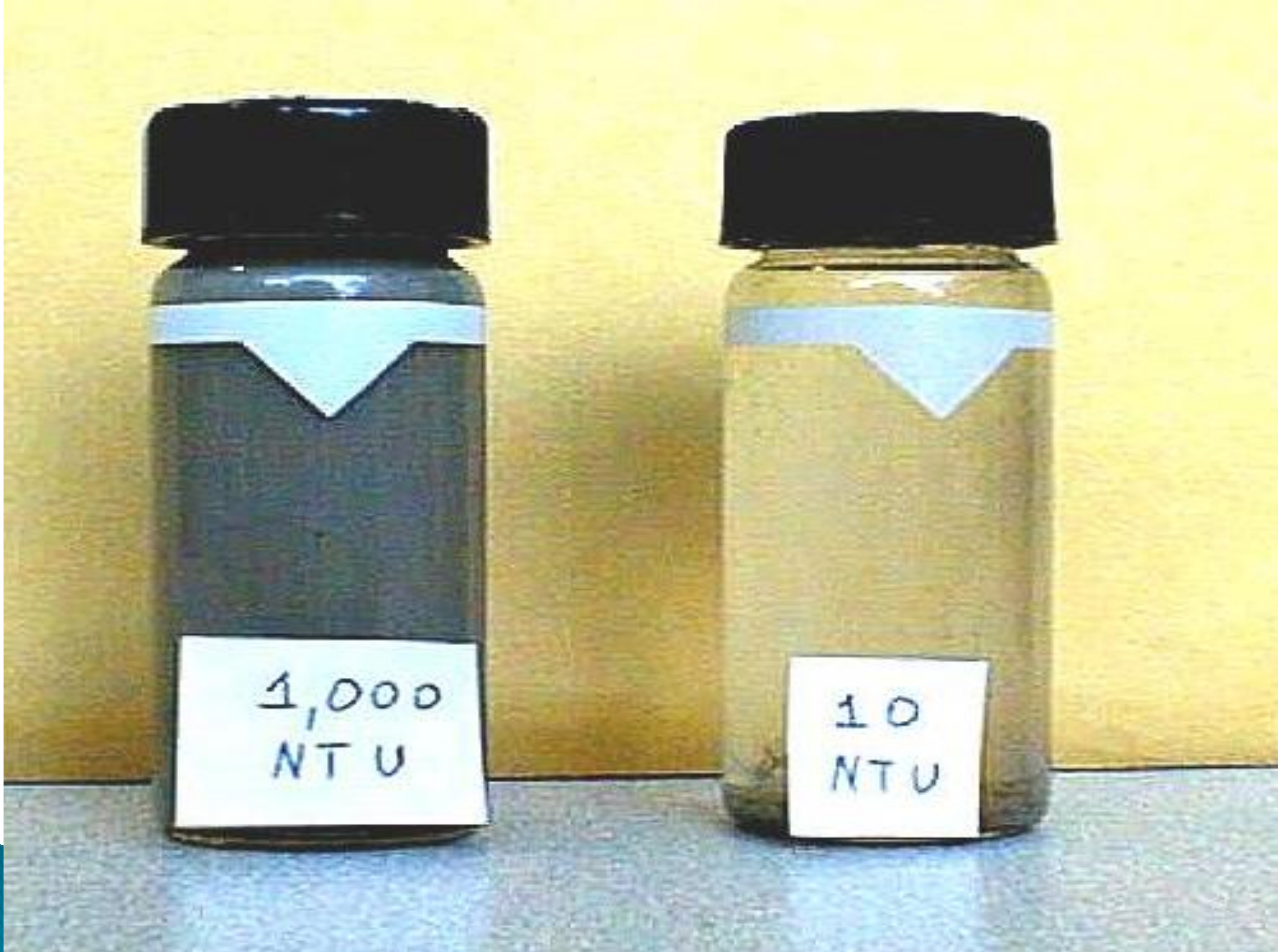
| Rank | Description of effect |
|---|---|
| 14 | >80 to 100% mortality |
| 13 | >60 to 80% mortality |
| 12 | >40 to 60% mortality, severe habitat degradation |
| 11 | >20 to 40% mortality |
| 10 | 0 to 20% mortality |
| 9 | Reduction in growth rates |
| 8 | Physiological stress and histological changes |
| 7 | Moderate habitat degradation |
| 6 | Poor condition of organism |
| 5 | Impaired homing |
| 4 | Reduction in feeding rates |
| 3 | Avoidance response, abandonment of cover |
| 2 | Alarm reaction, avoidance reaction |
| 1 | Increased coughing rate |






http://duluthstreams.org/understanding/param_turbidity.html

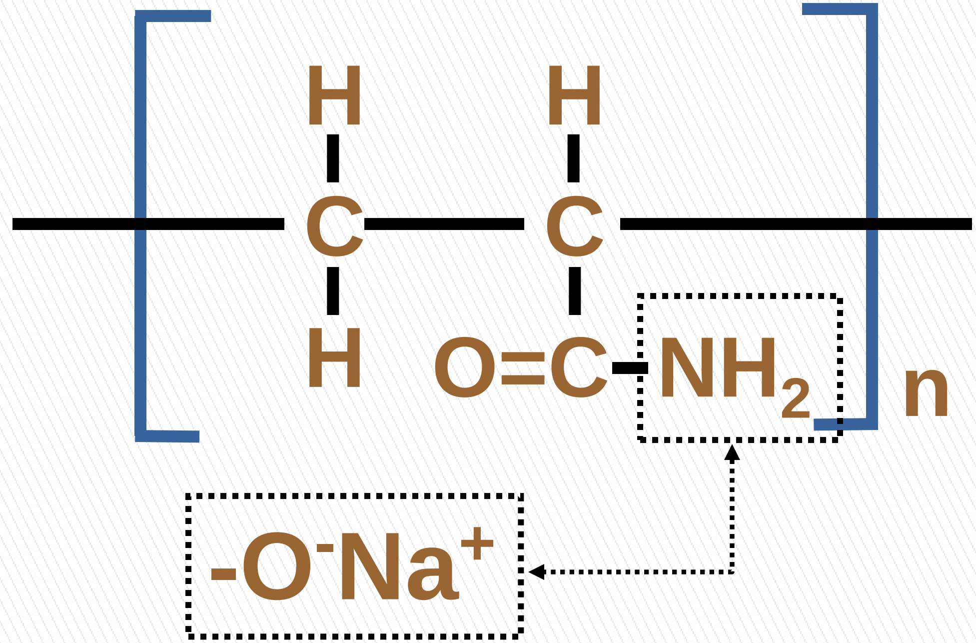
Schematic adapted from "Turbidty: A Water Quality Measure", Water Action Volunteers, Monitoring Factsheet Series, UW-Extension, Environmental Resources Center. It is a generic, un-calibrated impact assessment model based on Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693-7


1,000
NTU
10
NTU

# Polymer Basics

# Anionic Polyacrylamide (PAM)

- PAM is a polymer of acrylamide (AMD) monomers
- Erosion PAMs are 12 to 24 Mg/mole & >150,000 chained monomers/molecule
- Erosion PAMs have <0.05% unreacted AMD



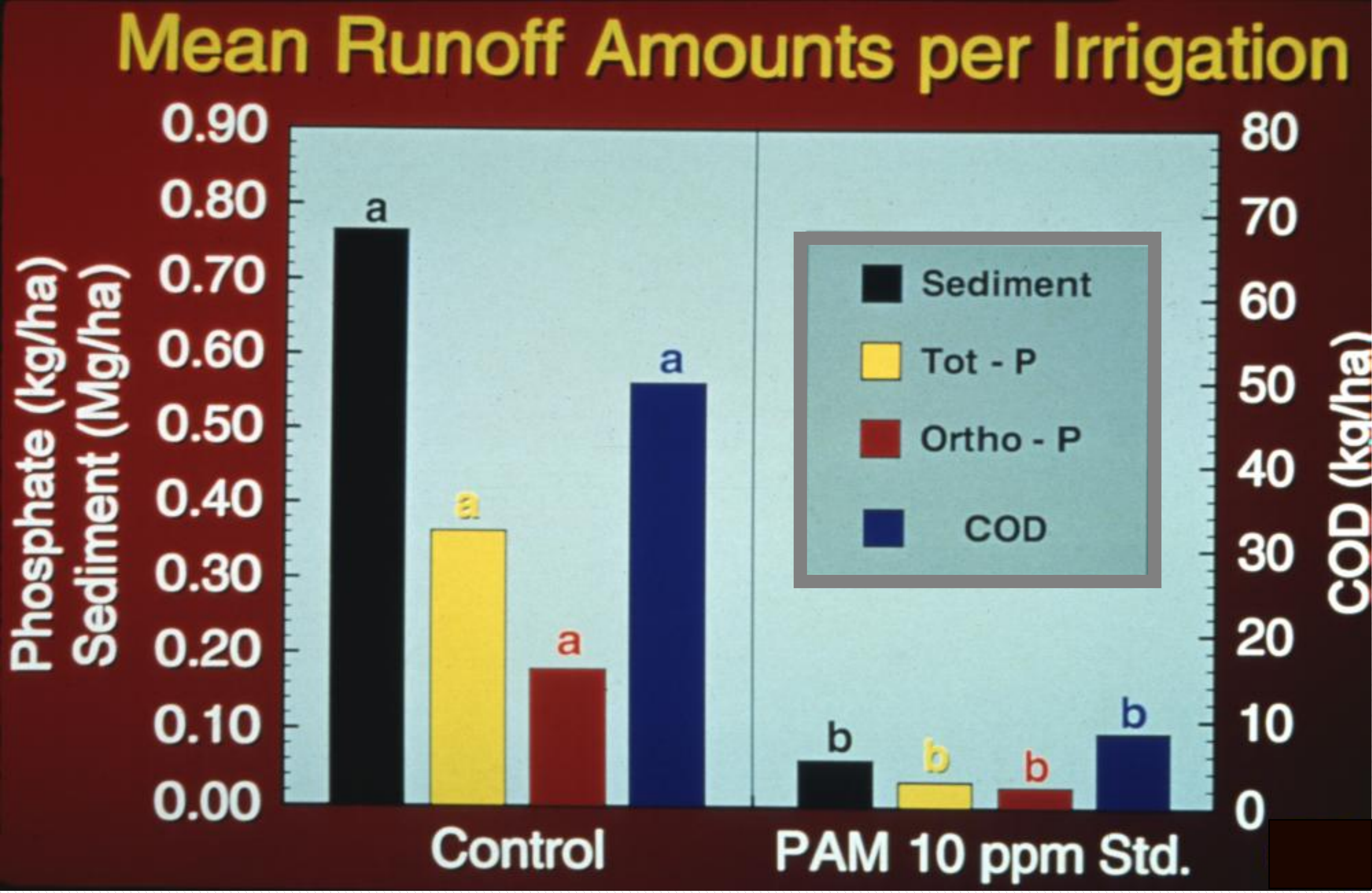


NWISRL
KIMBERLY, ID

# USDA Has Used PAM To:

- Reduce Agricultural Erosion
- Increase Soil Infiltration
- Improve Crop Yield

# Anionic Erosion and Water clarification PAM based polymers are <u>FAR</u> less toxic than Fungicides, Insecticides, Rodenticides, Cationic Polymers, most Herbicides and even concentrated Fertilizers




**California & Idaho Research Also Show Reduced Pesticide in Runoff**

NWISRL
KIMBERLY, ID

# Uses of Polyacrylamide

Removal of suspended solids from industrial waste water before discharging, reuse, or disposal

***Clarify fruit juices and sugar liquors***

**COSMETICS**

**Flocculent in the treatment of municipal water supply**

*Mineral Processing*

POTABLE WATER

**-Mining and Drilling applications-**

**Adhesives and Paper in contact with food**

**Paper and Pulp Production**

***Animal Feed Thickener***

***Soil conditioning agent***

# Toxicity and Performance Testing

# ASTM Procedure for Aquatic Toxicity Testing – WET Test

Designation: E 1023 - 84 (Reapproved 2002)

## Standard Guide for Assessing the Hazard of a Material to Aquatic Organisms and Their Uses[1]

This standard is issued under the fixed designation E 1023; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide describes a stepwise process for using information concerning the biological, chemical, physical, and lexicological properties of a material to identify adverse effects likely to occur to aquatic organisms and their uses as a result of release of the material to the environment. The material will usually be a specific chemical, although it might be a group of chemicals that have very similar biological, chemical, physical, and toxicological properties and are usually produced, used, and discarded together.

1.2 The hazard assessment process is complex and requires decisions at a number of points; thus, the validity of a hazard assessment depends on the soundness of those decisions, as well as the accuracy of the information used. All decisions should be based on reasonable worst-case analyses so that an appropriate assessment can be completed for the least cost that is consistent with scientific validity.

1.3 This guide assumes that the reader is knowledgeable in aquatic toxicology and related pertinent areas. A list of general references is provided (1).[2]

1.4 This guide does not describe or reference detailed procedures for estimating or measuring environmental concentrations, or procedures for determining the maximum concentration of test material that is acceptable in the food of predators of aquatic life. However, this guide does describe how such information should be used when assessing the hazard of a material to aquatic organisms and their uses.

1.5 Because assessment of hazard to aquatic organisms and their uses is a relatively new activity within aquatic toxicology, most of the guidance provided herein is qualitative rather than quantitative. When possible, confidence limits should be calculated and taken into account.

1.6 This guide provides guidance for assessing hazard but does not provide guidance on how to take into account social considerations in order to judge the acceptability of the hazard. Judgments concerning acceptability are social as well as scientific, and are outside the scope of this guide.

1.7 This guide is arranged as follows:



[1] This guide is under the jurisdiction of ASTM Committee E47 on Biological Effects and Environmental Fate and is the direct responsibility of Subcommittee E47.04 on Environmental Fate of Chemical Substances.
Current edition approved Sept. 28, 1984. Published June 1985.
[2] Boldface numbers in parentheses refer to the list of references at the end of this standard.



Note: Floc Log testing was conducted using worst case analysis. All toxicity tests were conducted using ASTM procedure at full chemical exposure.

* Chitosan tests were conducted using effluent after reaction and filtration. This is not worst-case analysis and does not follow the ASTM procedure.

## Toxicity Studies for Chitosan (poly-N-acetyl-D-glucosamine)

| Test Species | Scientific Name | Avg Species LC50 | LC50 Std Dev | Number of Studies | Average Species Rating |
|---|---|---|---|---|---|
| Channel Catfish | *Ictalurus punctatus* | 64.5 ug/L **(0.0645 mg/L)** | 27.5 | 2 | Very Highly Toxic |
| Rainbow Trout | *Oncorhynchus mykiss* | 44.0 ug/L **(0.044 mg/L)** | 6.00 | 2 | Very Highly Toxic |

Citation: S. Orme and S. Kegley, *PAN Pesticide Database*, Pesticide Action Network, North America (San Fransisco, CA. 2006), http:www.pestisideinfo.org.

Information found at: http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34013

Studies:
Bullock, G., V. Blazer, S. Tsukuda, and S. Summerfelt. *Toxicity of Acidified Chitosan for Cultured Rainbow Trout (Oncorfhynchus mykiss)*. Aquaculture 185(3/4): 273-280. Publication year: 2000.

Waller, D.L., J.J. Rach, W.G. Cope, L.L. Marking, S.W. Fisher, and H. Dabrowska. *Toxicity of Candidiate Molluscicides to Zebra Mussels (Dreissena polymorpha) and Selected Nontarget Organisms*. J. Gt. Lakes Res. 19(4): 695-702. Publication year: 1993.

## Comparison of Common Polymers used for Stormwater Applications

| Polymer LC50 Values (mg/L) | | | |
|---|---|---|---|
| **Polymer** | ***D. magna* 48 hr.** | ***O. mykiss* 96 hr.** | ***P. promelas* 96 hr.** |
| $Al_2Cl(OH)_5$ | > 5000 | 390 | 517 |
| DADMAC | 17.5 | 0.49 | 1.65 |
| Mimosa Bark | 258 | No Data | 1.3 |
| Chitosan | 13.7 | 1.1 | 6.4 |
| Note that the Chitosan is considered a hazardous substance according to federal Resource Conservation and Recovery Act (RCRA) standards (due to acidity, at a pH of about 4), while many synthetic polymers such as DADMAC are not RCRA hazardous. | | | |

Citation: Protech General Contracting Services, Inc. *Technical Report July 2004: Polymer Coagulants and Flocculants For Stormwater Applications*. (Napa, CA. 2004)
Information found at: www.protech-services-inc.com

| Polymer LC50 Values (mg/L) | | | |
|---|---|---|---|
| **Polymer** | ***D. magna* 48 hr.** | ***O. mykiss* 96 hr.** | ***P. promelas* 96 hr.** |
| APS 706b Floc Log | > 420 [1] | 637 [1] | > 1680 [1] |
| APS 703d Floc Log | 383 [2] | 1900 [3] | No Data |
| APS 712 powder | 1617 [2] | No Data | > 6720 [2] |

Information available at: http://www.siltstop.com/msds_toxicity_reports.html.
Citation: Third-party acute toxicity testing by certified testing laboratories following appropriate EPA protocol.

1) BioTox Laboratory, LAW Engineering & Environmental Services Inc. Kennesaw, GA.
2) BioTox Laboratory, Mactec Engineering & Consulting Inc. Kennesaw, GA.
3) Maxxam Analytics Inc. Edmonton, Alberta, CANADA.

# PERFORMANCE

- One PAM does not work on all soil and water chemistries
- Performance testing before applying is necessary to ensure results
- Can be done doing a simple "cup test"
- Using an incorrect PAM:
  - You may not see results
  - It may not bind to your soil at all

# Hard Armoring

- Hard armoring is a structural method for erosion control. Hard armoring includes a variety of techniques including rock riprap (large stones placed along the slope of a streambank or shoreline) and gabions (rock-filled wire baskets placed along a streambank or shoreline). Hard armoring typically involves grading the bank to a gentler slope. If done properly, these techniques provide very good protection and will work in severe situations where bioengineering will not. However, hard armoring techniques can be relatively expensive, and may require professional assistance. These techniques are often used in situations where less expensive, more environmentally friendly and aesthetically pleasing alternatives would have been successful.


Looking North

# Soft Armoring

- Soft armoring is a natural protection method that is gentle on the environment, imitate natural systems, can interact naturally within the ecosystem, as well as save you a significant amount of money. Soft armoring is often referred to as live plants, logs, root wads, vegetative mats, and aslo can be soft pliable open weave mats such as jute, coconut, hemp, burlap, etc.

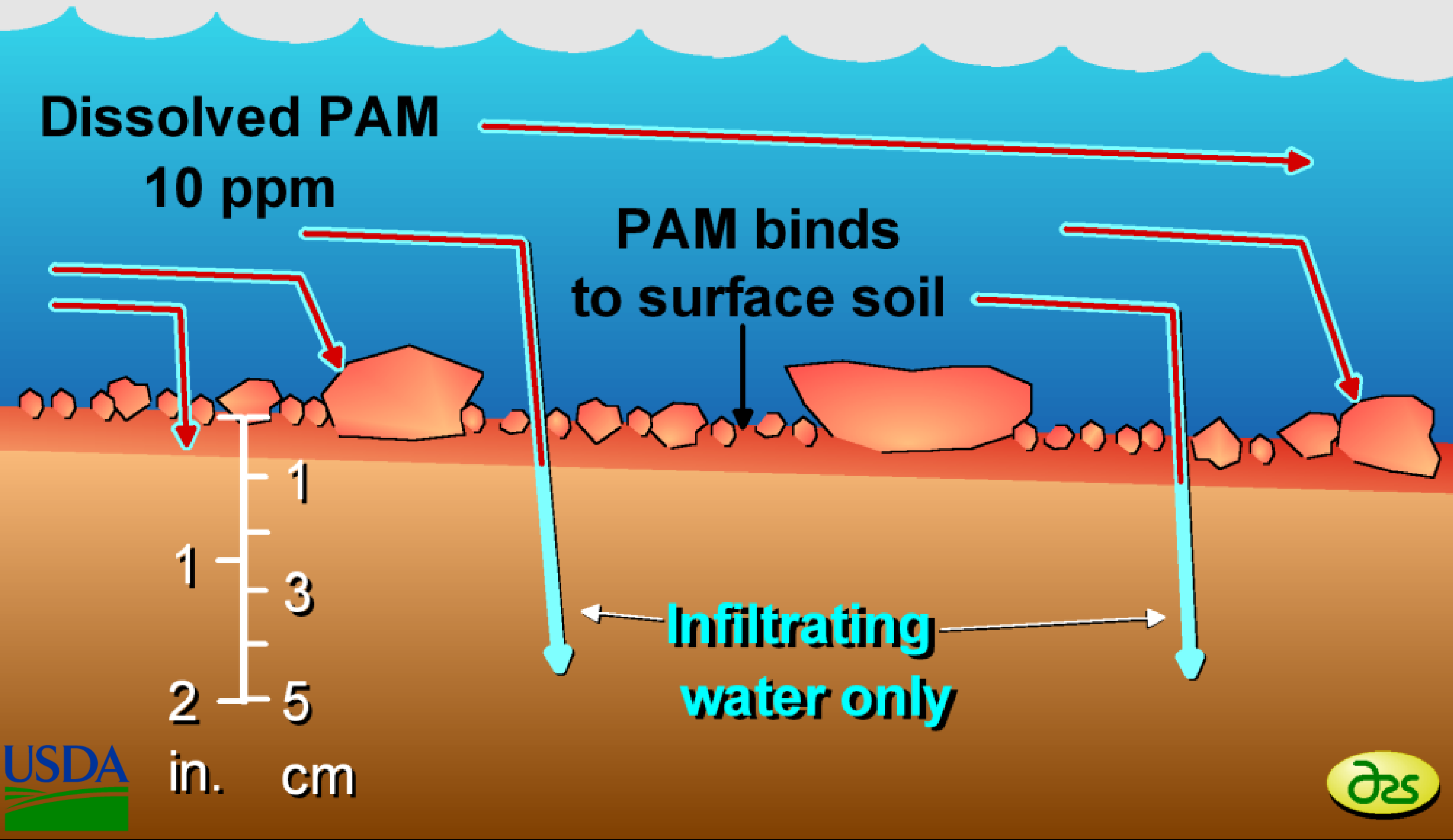
# Soft Armoring with Matting

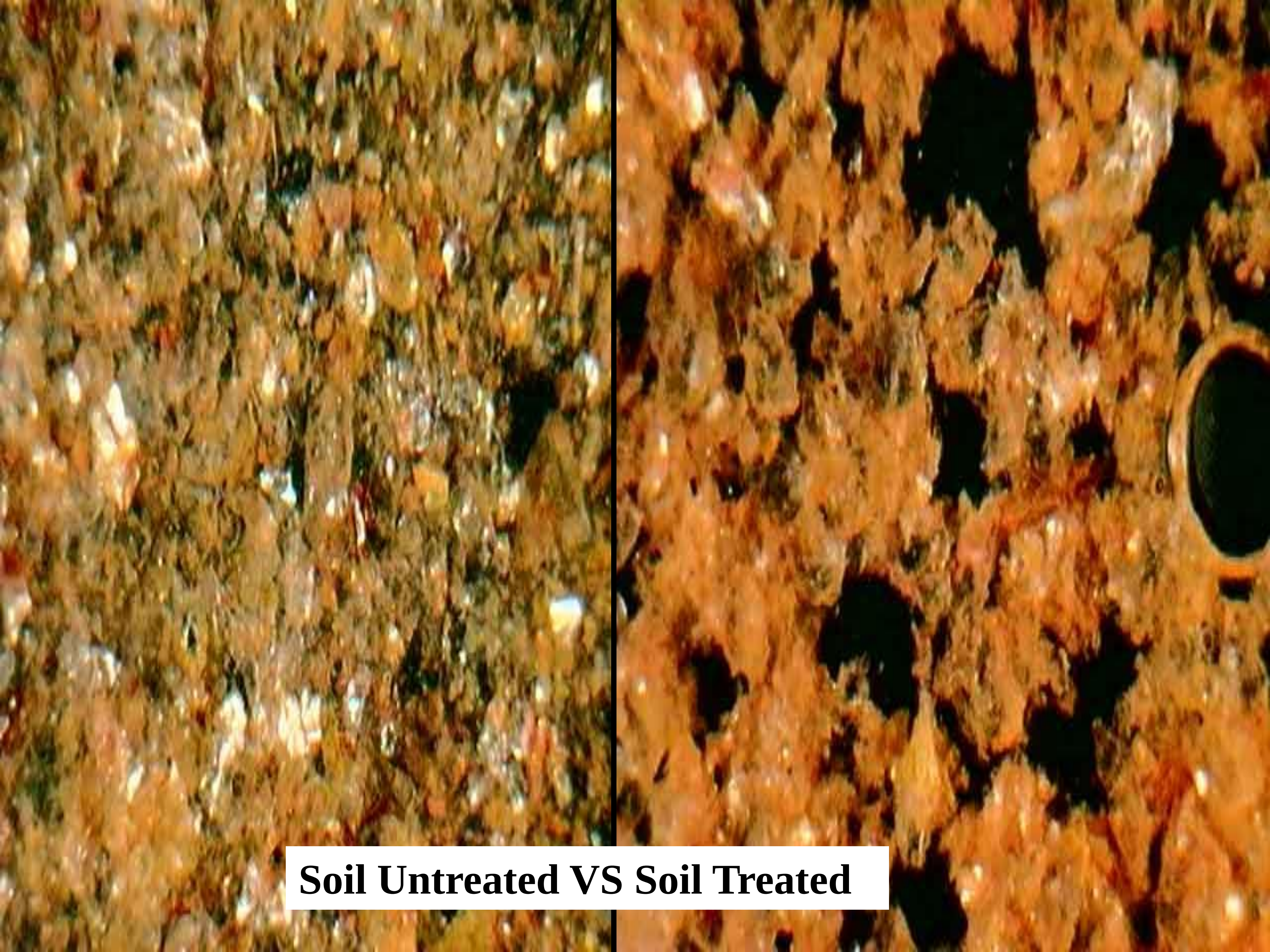
# Polymer Enhanced Soil Stabilization

## (Including Polymer Enhanced Soft Armoring technique)

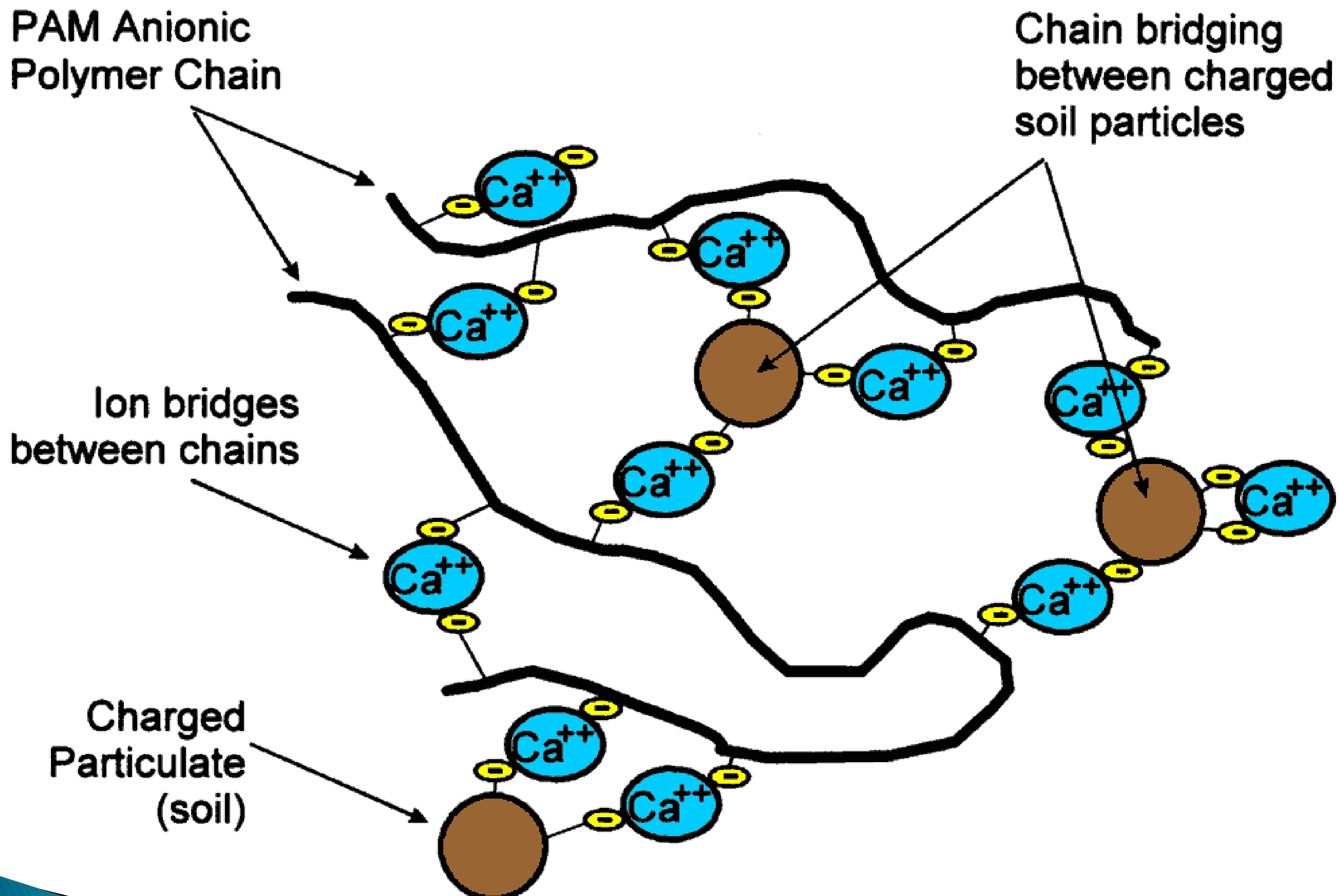
**Water Quality/Stream Impairment? Site Erosion?**

# PAM-Treated Furrow Irrigation

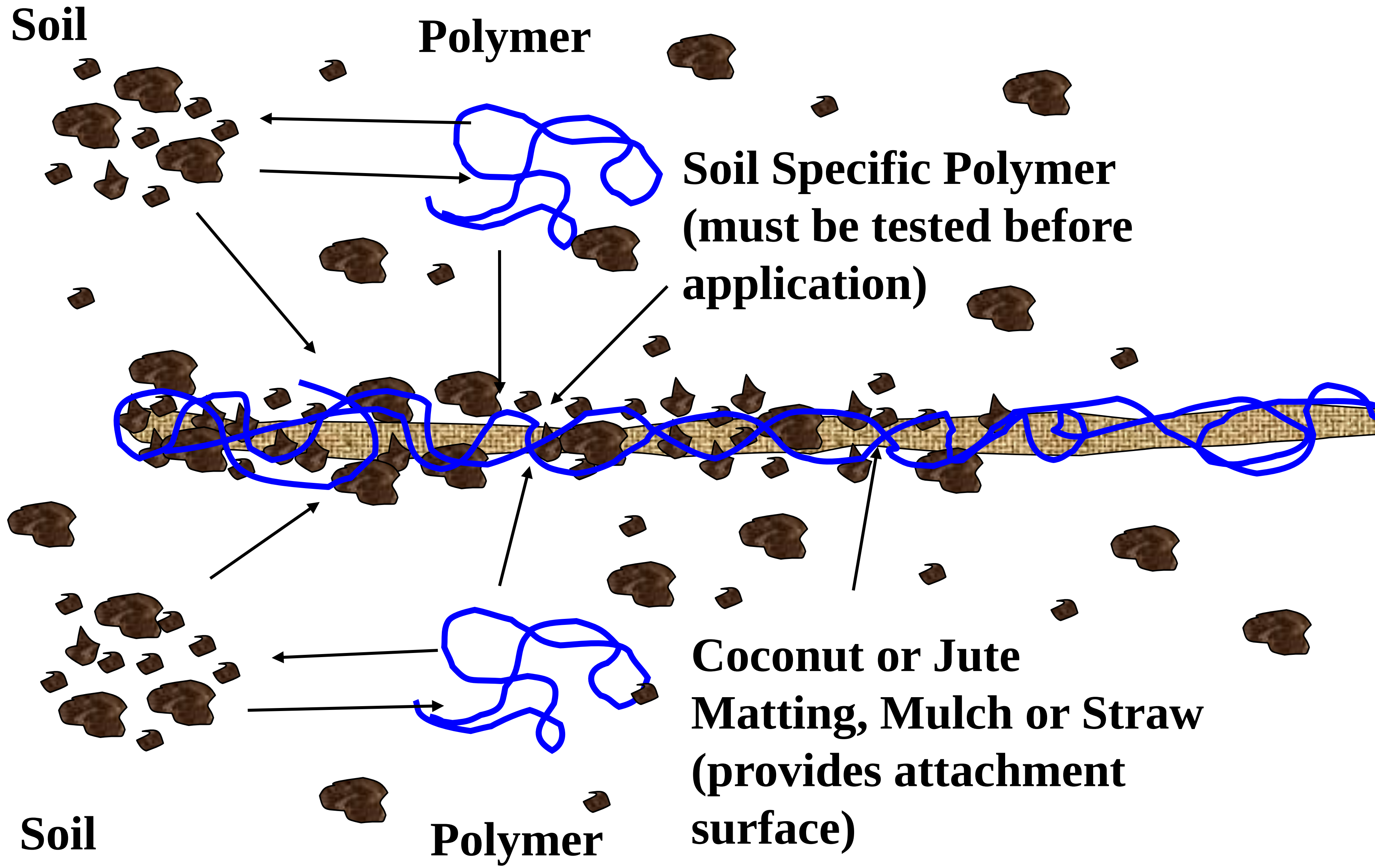


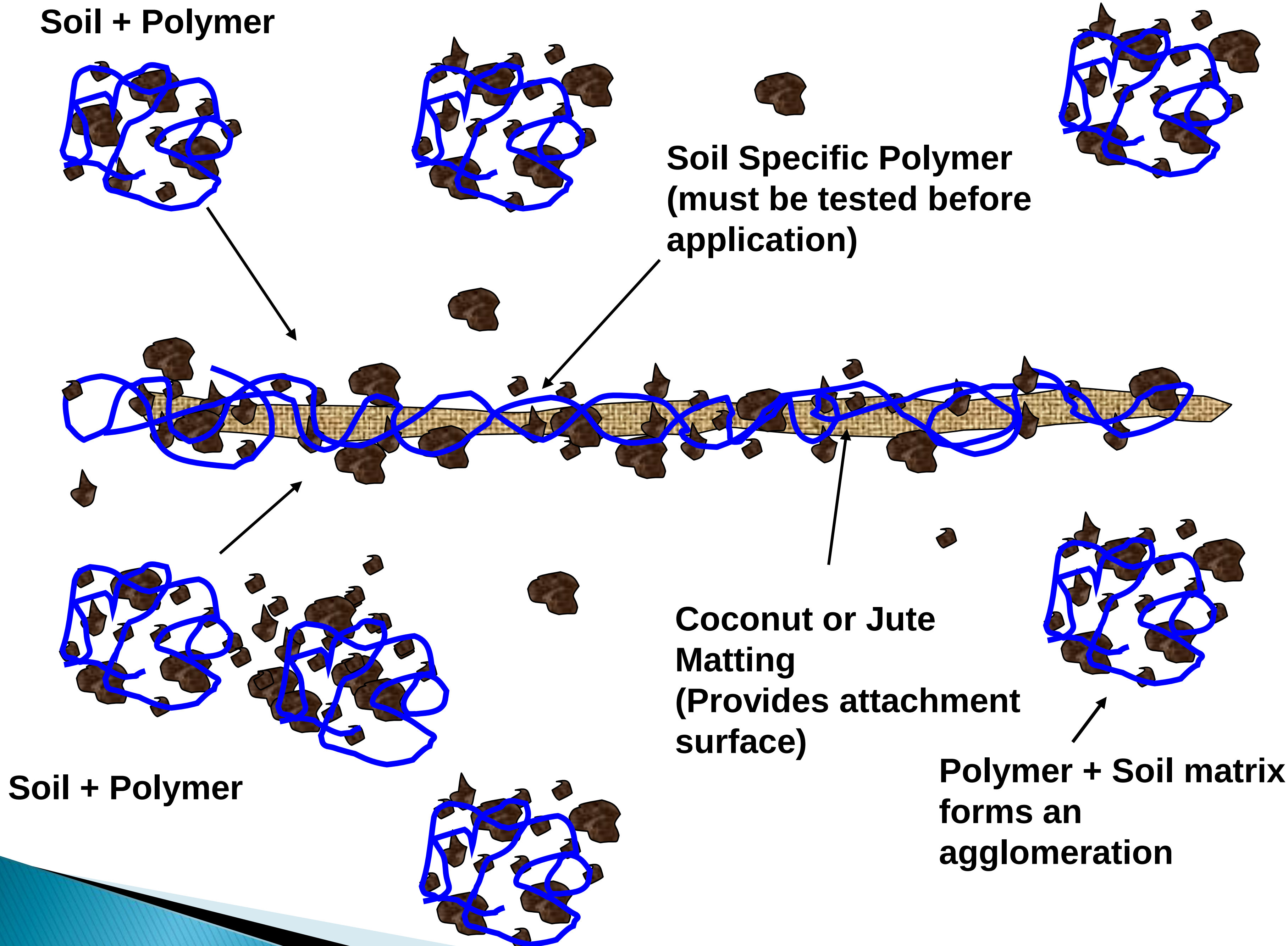


**Soil Untreated VS Soil Treated**

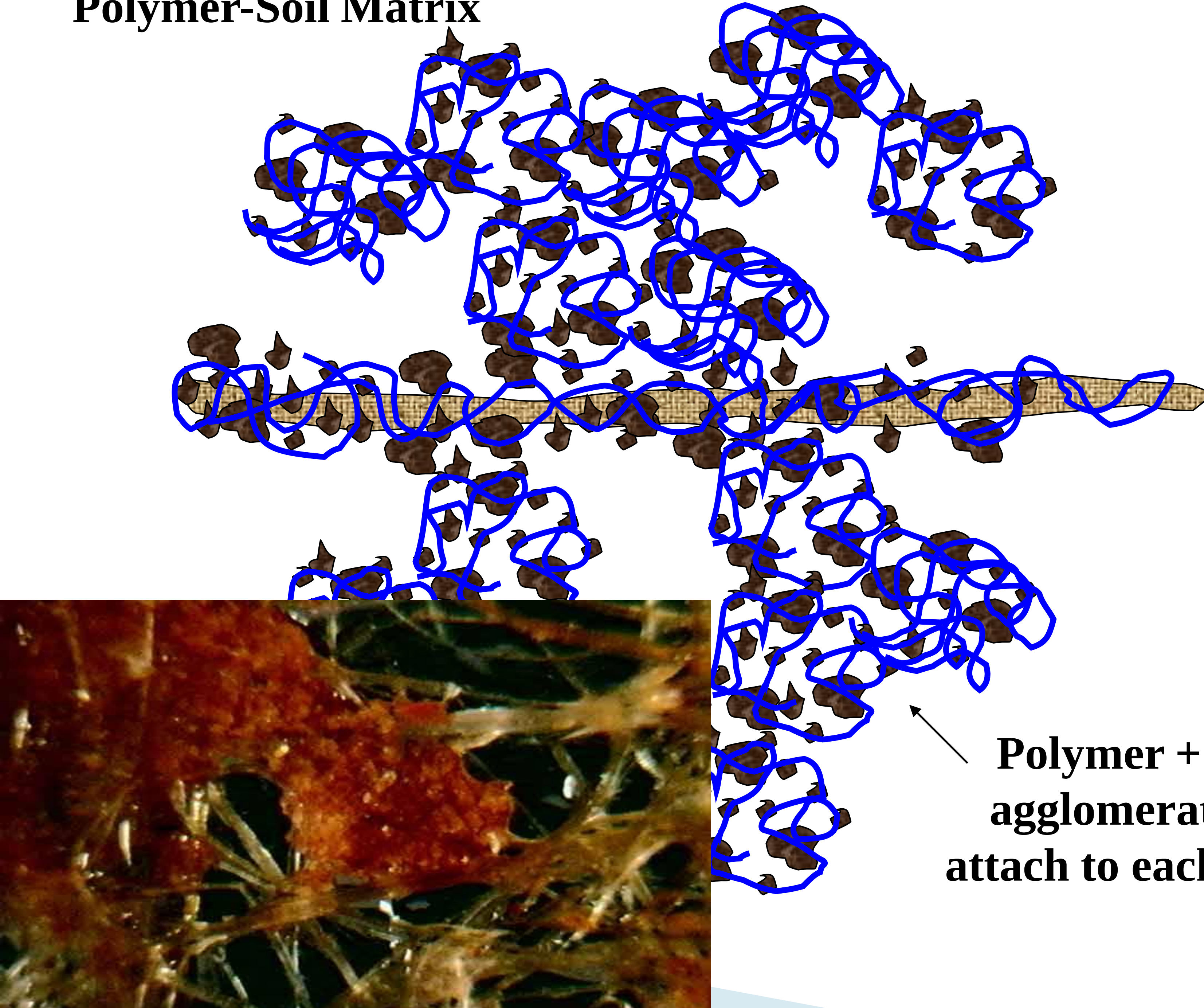

PAM Anionic
Polymer Chain
Chain bridging
between charged
soil particles
Ion bridges
between chains
Charged
Particulate
(soil)
Ca++

Open weave soft matting works best


Soil
Polymer
Soil Specific Polymer (must be tested before application)
Coconut or Jute Matting, Mulch or Straw (provides attachment surface)
Soil
Polymer


Soil + Polymer
Soil Specific Polymer (must be tested before application)
Coconut or Jute Matting (Provides attachment surface)
Soil + Polymer
Polymer + Soil matrix forms an agglomeration

# Polymer-Soil Matrix



Polymer + Soil
agglomerations
attach to each other

# Benefits of Vegetation in Erosion & Sediment Control

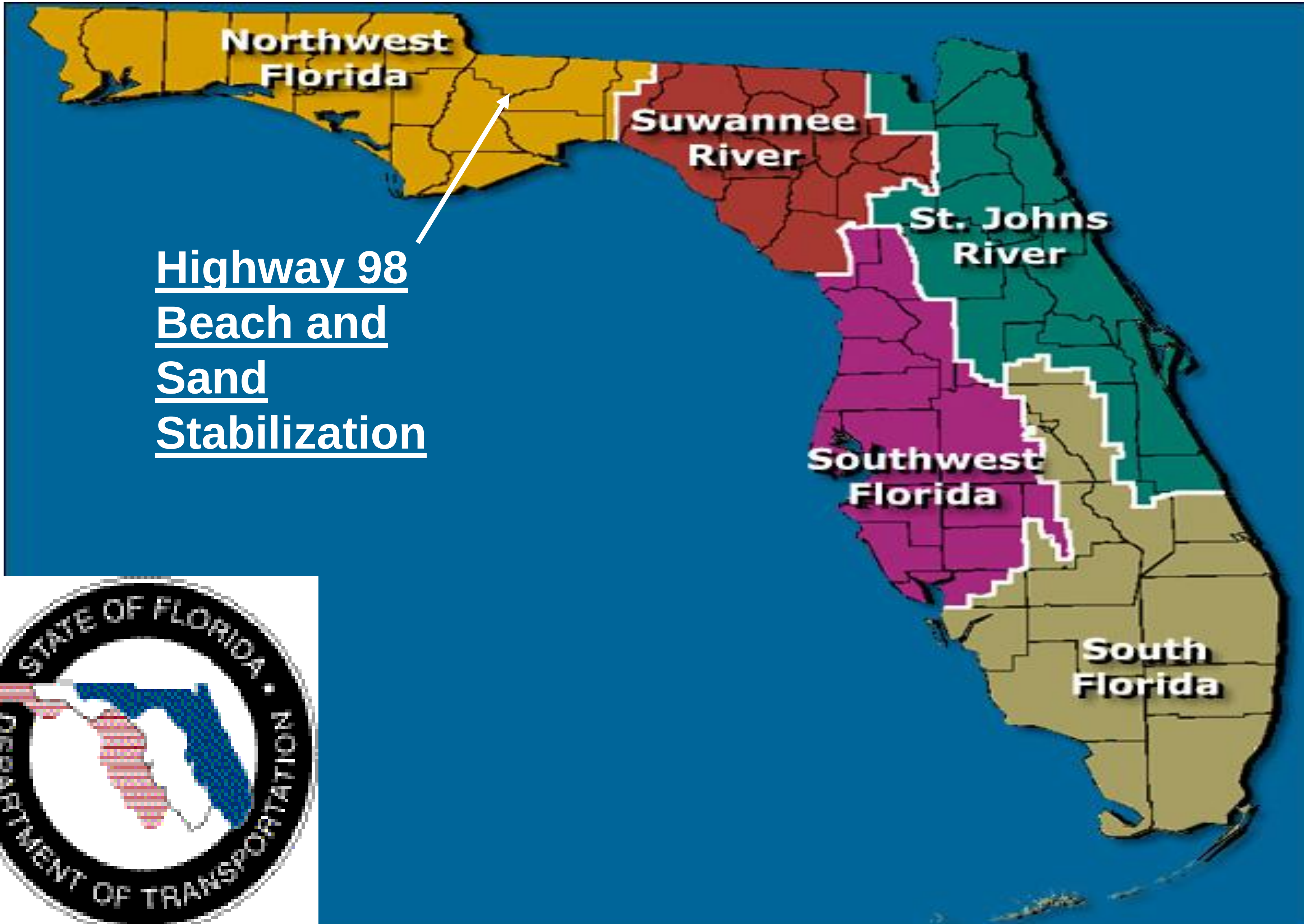
"The optimal erosion control practice is to maintain existing vegetation or when lands are disturbed, establish new vegetation. As with check dams, vegetation can serve two purposes, namely, capture sediment and minimize erosion." (STATE OF FLORIDA EROSION & SEDIMENT CONTROL – DESIGNER & REVIEWER MANUAL)

"The most efficient and economical method for controlling erosion and minimizing sediment yields is to establish a vegetative cover. Two common methods used in Florida are to place and establish sod on disturbed lands or plant seed." (STATE OF FLORIDA EROSION & SEDIMENT CONTROL – DESIGNER & REVIEWER MANUAL)

# Soft armoring with matting

# Soft Armoring with Matting

# HWY 98 DOT Project



**Highway 98 Damage by Hurricane Dennis**

**July 2005 (Carabelle to Eastpoint)**

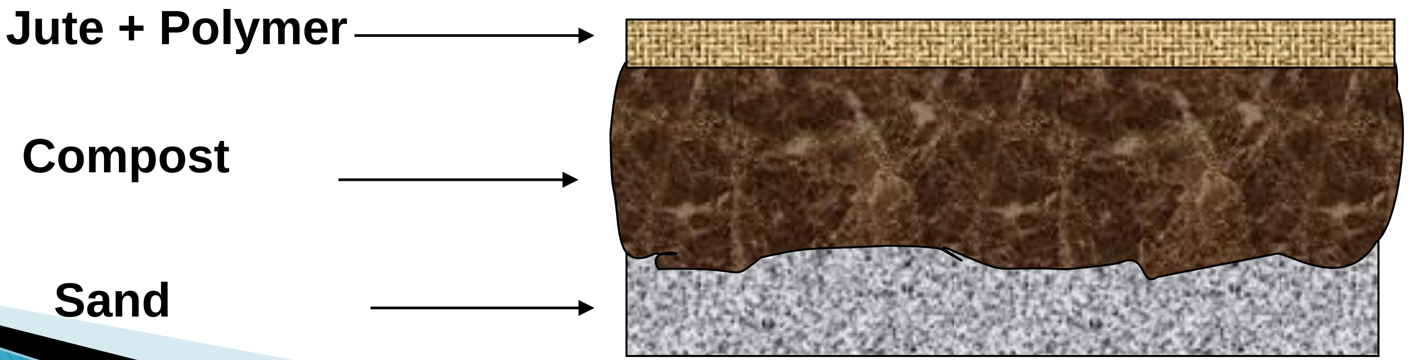
**Highway 98 Repair - Carabelle to Eastpoint**

Erosion after initial repair required an industrial BMP that would work on beach sands

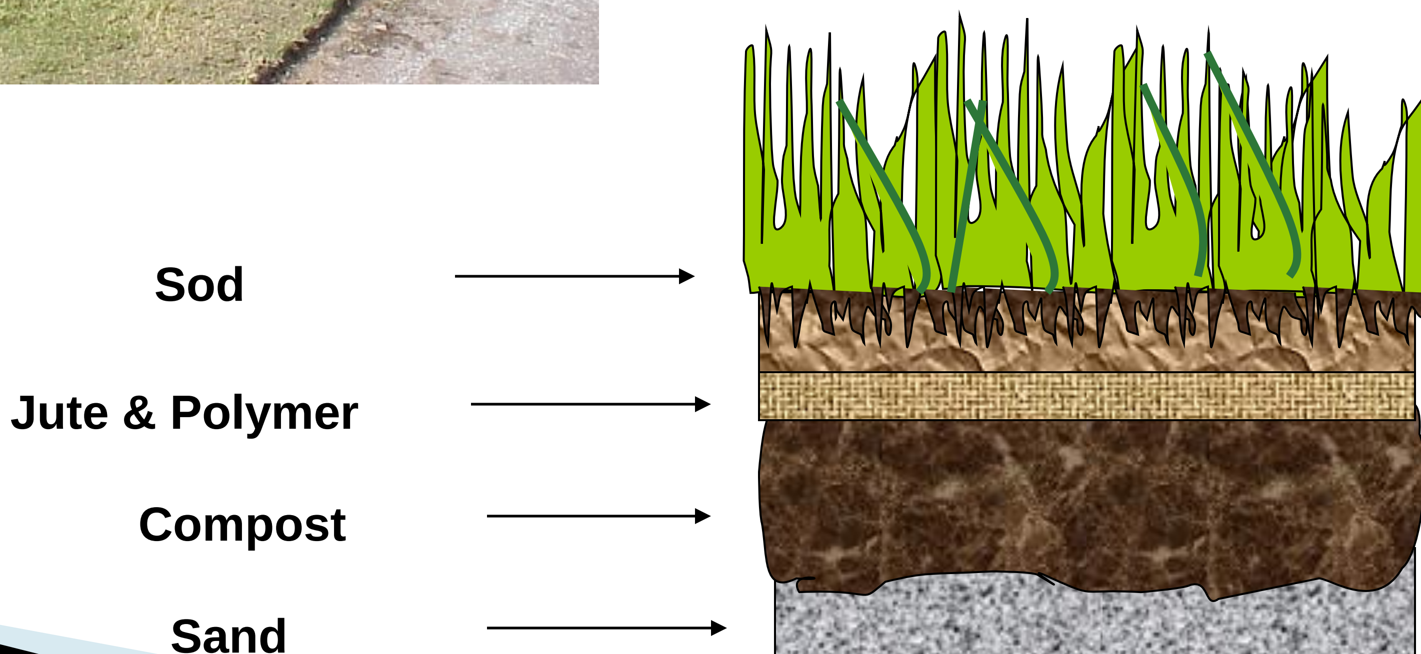

Polymer Enhanced Soft Armor Systems was chosen. After grading, compost was placed as an organic layer

Jute matting was placed over the organic layer as a binding media for attachment of the polymer, sand and soil

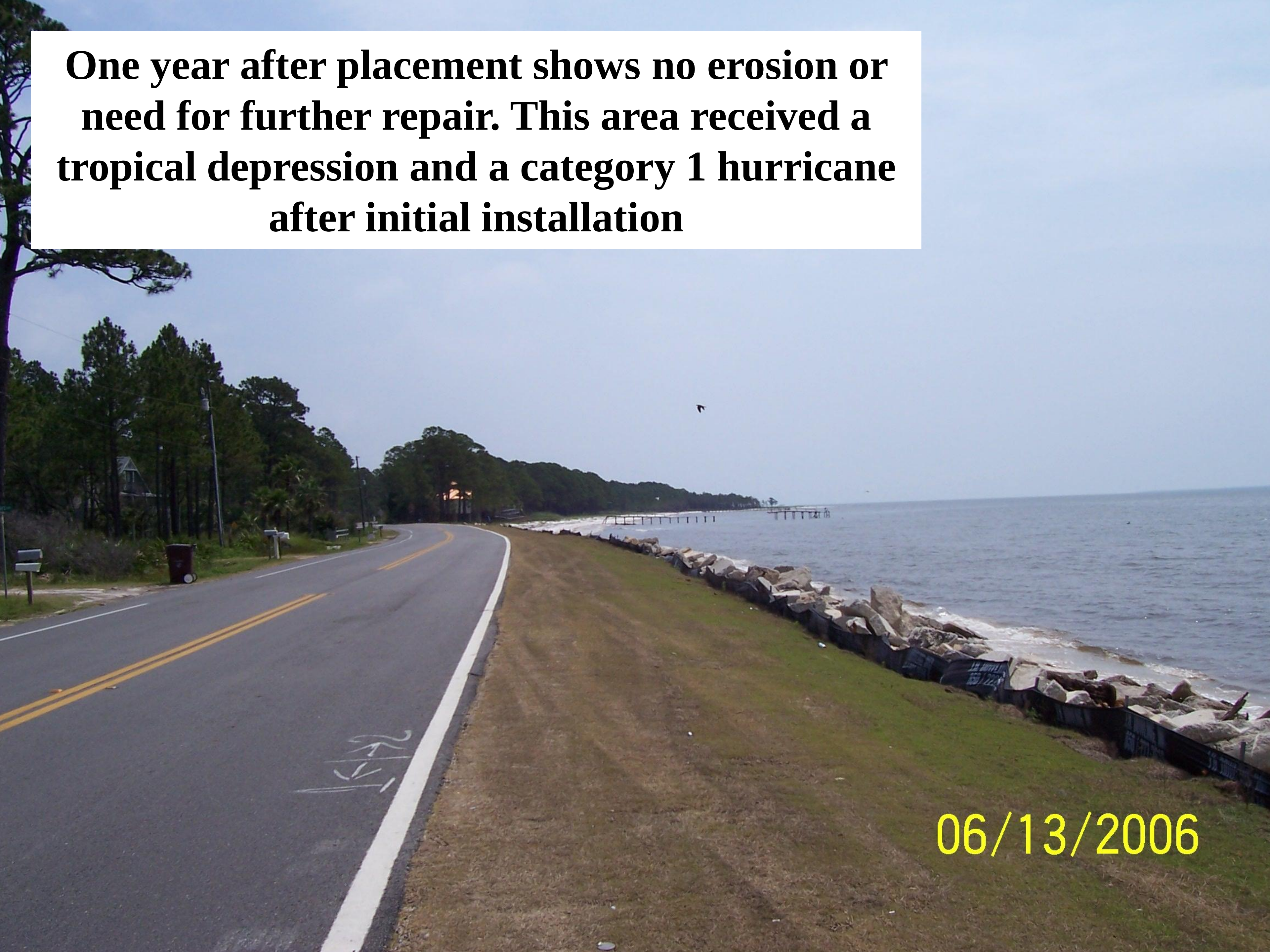

Jute matting was placed over the 14 miles of repair area as a binding agent.  50 pounds / acre polymer application rate was used



**Sod was placed over the polymer enhanced BMP**



**One year after placement shows no erosion or need for further repair. This area received a tropical depression and a category 1 hurricane after initial installation**



# Lake Independence

# Shoreline Stabilization

## (Hard Armoring Application)





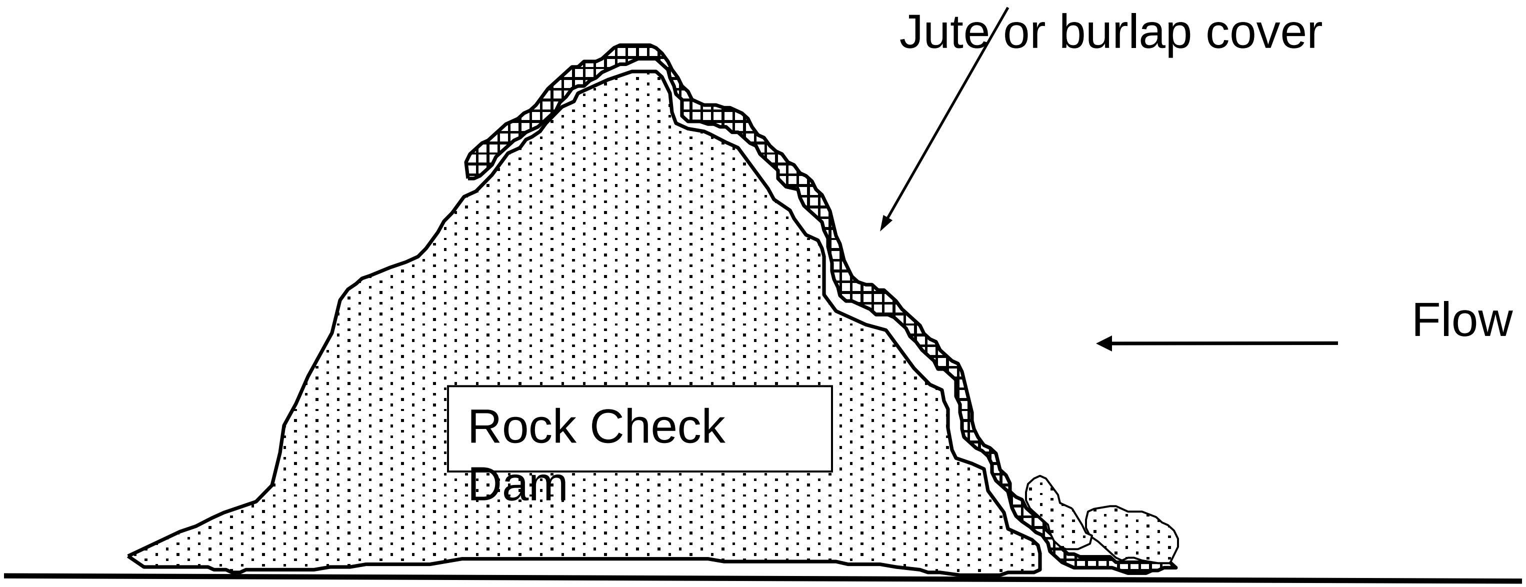
Before
After

# Polymer Enhanced Hydroseeding

# Some Additional Applications using PAM…..

# Polymer Enhanced Rock Checks/Wattles

# Polymer Enhanced Rock Checks/Wattles




**Apply the correct soil specific polymer to the matting**

# Polymer Enhanced Rock Checks/Wattles

# Polymer Enhanced Rock Checks/Wattles

# Sediment Retention Barriers (SRBs)

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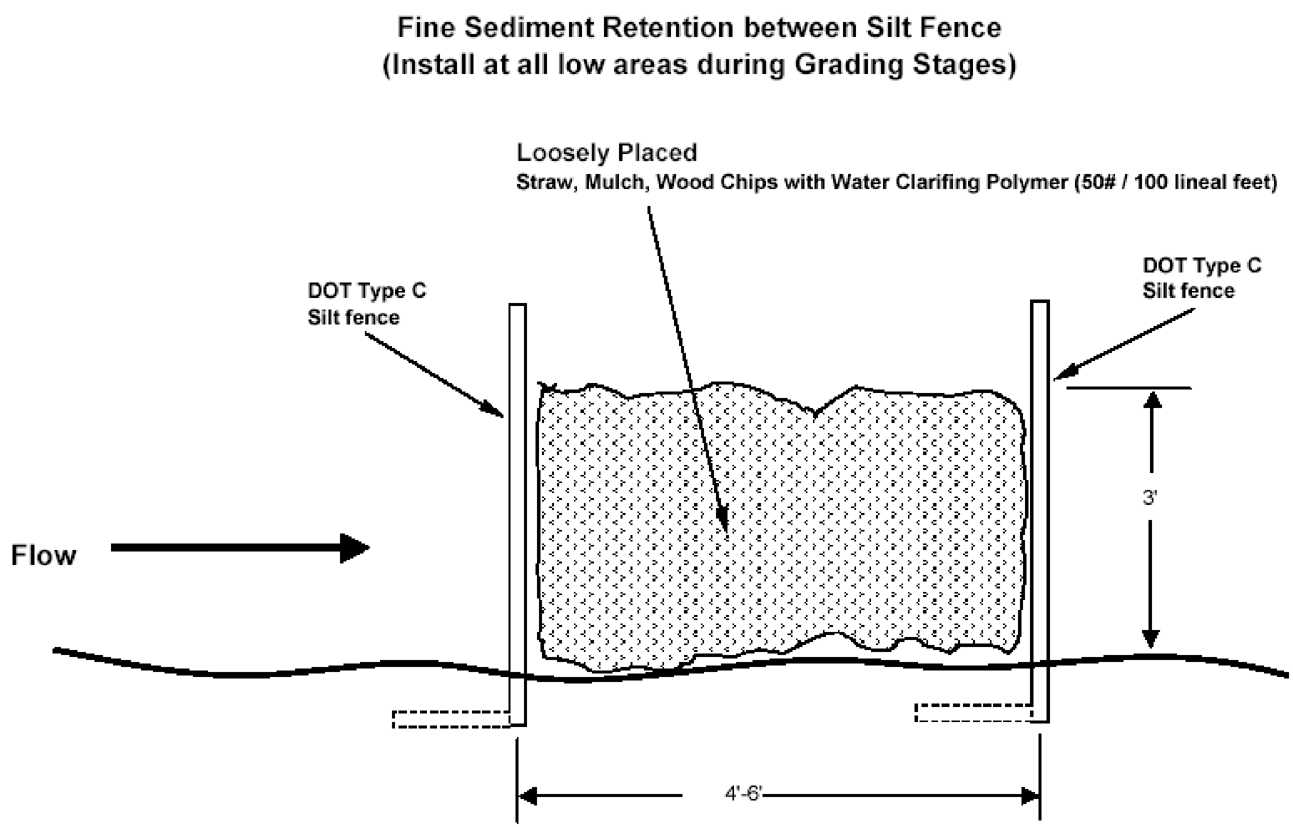

# Sediment Retention Barriers (SRBs)

# Sediment Retention Barriers (SRBs)

# Sediment Retention Barriers (SRBs) in a treatment train

# Sediment Retention Barriers (SRBs) in a treatment train

# Sediment Retention Barriers (SRBs) in a treatment train

# Sediment Retention Barriers (SRBs) in a treatment train

# Mud/sediment Removal

# Mud/sediment Removal

# Mud/sediment Removal

# Mud/sediment Removal

# Mud/sediment Removal

# Mud/sediment Removal

Cobb County Soil & Water Conservation District

Applied Polymer Systems, Inc.
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Woodstock, GA 30189
www.siltstop.com

# Anna River Culvert Replacement Project 2010

Senior Associate

The Anna River culvert replacement project was carried out in the fall of 2010 to replace an old metal culvert on Perch Lake Road that was beginning to rust away and potentially collapse and bury the Anna River. Due to Ana River being a live active salmon stream this project was permitted through Michigan Department of Environmental Quality and overseen by Algar Soil and Water Commission.

This project outlines key points in correctly using Polymer Enhanced Best Management Applications:

- Absence of toxicity to aquatic organisms (In this case spawning salmon)
- Polymers performance tested to ensure optimal results
- Polymer Enhanced BMP’s used in a treatment train to achieve optimal results (not BMP’s alone or polymers alone)

An excavator was used to begin the removal of the old culvert.

A diversionary wall was built to isolate the stream and divert it to the other side while the culvert was torn out.

Completion of the coffer dam to isolate the stream and send it through the diversionary ditch

The diversionary ditch was composed of limestone laid over a plastic liner. Polymer powder was applied to the limestone to prevent any sedimentation.

New bedding was installed in preparation of installation of a new concrete box culvert. Polymer powder was applied to this bedding to protect against any sedimentation.

Polymer enhance soft armored rock checks in the ditch next to the new road to capture sediment moving into the stream.

Polymer enhanced soft armoring was installed to stabilize the areas where sediment could move into the stream.

Polymer powder, fertilizer and seed were mixed together to be used to start the stabilization process on all the bare, disturbed soil along the edges of the road.

The polymer, seed and fertilizer mixture was loaded into a spreader.

The mixture was spread on all areas of bare soil. The polymer not only stabilized the soil but prevents the seed and fertilizer from washing into the stream.

One year after installation.

# Rules of Polymer Use

1) Polymer must be non-toxic to aquatic organisms having EPA certified toxicity reports (whole product WET tests using ASTM guidelines)

2) Each site application must demonstrate 95% or better NTU reduction test reports. Each polymer can be unique for each application. One polymer does not work on all soils.

3) Polymers must be used in combination with other BMP's in a "treatment train" to ensure optimum results.

# Polymer References

http://kimberly.ars.usda.gov/pampage.shtml

www.stormwater.ucf.edu

www.siltstop.com

**Go to:**

**(Polymer Enhanced BMP Application Guide)**