Using Anionic Flocculant Logs To Achieve Maximum Turbidity Reduction From Construction Projects

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Flocculant/ PAM introduction

Why Chemical Additions?

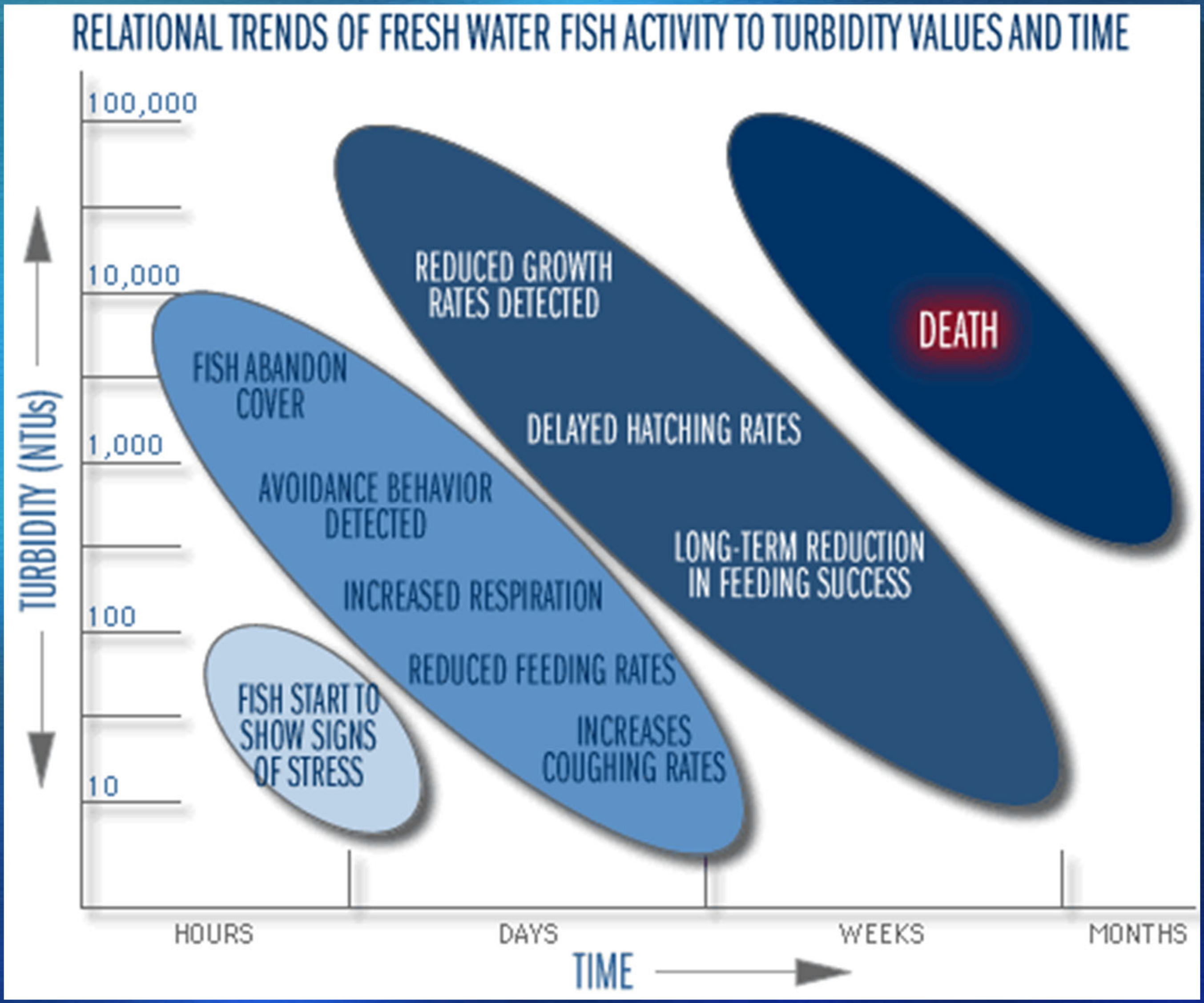
- MANY CONTAMINANTS NOT REMOVED BY CONVENTIONAL EROSION AND STORM WATER BMPS
- REACH WATER RESOURCES
  - *COLLOIDAL CLAYS AND SILT*
  - *METALS*
  - *BACTERIA*
- SOLUTION?
  - *FLOCCULANTS*
  - *COAGULANTS*

How Does Turbidity Affect Fish?

Turbidity Is Toxic To Aquatic Life

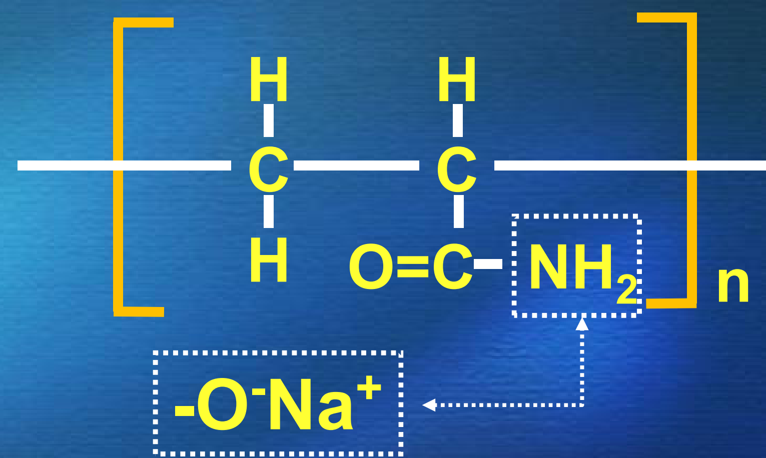
Turbidity Impacts On Fish:

Concentration vs. Time



ANIONIC POLYACRYLAMIDE (PAM)?

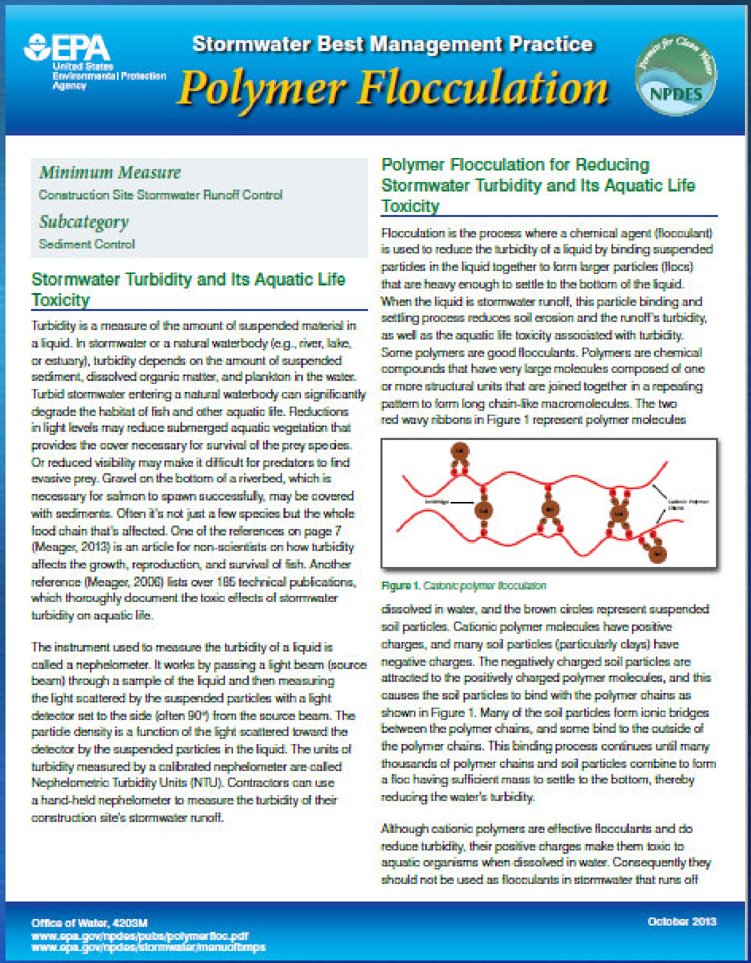
- LARGE, WATER-SOLUBLE POLYMER
- REMOVES >90% NTU/ TSS
  - *SEDIMENT, CLAY*
  - *METALS*
  - *PHOSPHORUS*
- SAFE FOR FISH AND AQUATIC ORGANISMS



Forms/ Types of PAM

- POWDER/ GRANULAR
  - *SILT STOP 700 SERIES*
- BLOCK/ GEL LOG FORM
  - *FLOC LOG*
  - *POND LOG*
- EMULSIONS/ LIQUID
  - *SILT STOP 600 SERIES*

EPA Review Of Polymer Flocculation



EPA United States Environmental Protection Agency

Stormwater Best Management Practice

Polymer Flocculation

NPDES

Minimum Measure

Construction Site Stormwater Runoff Control

Subcategory

Sediment Control

Stormwater Turbidity and Its Aquatic Life Toxicity

Turbidity is a measure of the amount of suspended material in a liquid. In stormwater or a natural waterbody (e.g., river, lake, or estuary), turbidity depends on the amount of suspended sediment, dissolved organic matter, and plankton in the water. Turbid stormwater entering a natural waterbody can significantly degrade the habitat of fish and other aquatic life. Reductions in light levels may reduce submerged aquatic vegetation that provides the cover necessary for survival of the prey species. Or reduced visibility may make it difficult for predators to find evasive prey. Gravel on the bottom of a riverbed, which is necessary for salmon to spawn successfully, may be covered with sediments. Often it's not just a few species but the whole food chain that's affected. One of the references on page 7 (Meager, 2013) is an article for non-scientists on how turbidity affects the growth, reproduction, and survival of fish. Another reference (Meager, 2006) lists over 185 technical publications, which thoroughly document the toxic effects of stormwater turbidity on aquatic life.

The instrument used to measure the turbidity of a liquid is called a nephelometer. It works by passing a light beam (source beam) through a sample of the liquid and then measuring the light scattered by the suspended particles with a light detector set to the side (often 90°) from the source beam. The particle density is a function of the light scattered toward the detector by the suspended particles in the liquid. The units of turbidity measured by a calibrated nephelometer are called Nephelometric Turbidity Units (NTU). Contractors can use a hand-held nephelometer to measure the turbidity of their construction site's stormwater runoff.

Polymer Flocculation for Reducing Stormwater Turbidity and Its Aquatic Life Toxicity

Flocculation is the process where a chemical agent (flocculant) is used to reduce the turbidity of a liquid by binding suspended particles in the liquid together to form larger particles (flocs) that are heavy enough to settle to the bottom of the liquid. When the liquid is stormwater runoff, this particle binding and settling process reduces soil erosion and the runoff's turbidity, as well as the aquatic life toxicity associated with turbidity. Some polymers are good flocculants. Polymers are chemical compounds that have very large molecules composed of one or more structural units that are joined together in a repeating pattern to form long chain-like macromolecules. The two red wavy ribbons in Figure 1 represent polymer molecules

Figure 1. Cationic polymer flocculation

dissolved in water, and the brown circles represent suspended soil particles. Cationic polymer molecules have positive charges, and many soil particles (particularly clays) have negative charges. The negatively charged soil particles are attracted to the positively charged polymer molecules, and this causes the soil particles to bind with the polymer chains as shown in Figure 1. Many of the soil particles form ionic bridges between the polymer chains, and some bind to the outside of the polymer chains. This binding process continues until many thousands of polymer chains and soil particles combine to form a floc having sufficient mass to settle to the bottom, thereby reducing the water's turbidity.

Although cationic polymers are effective flocculants and do reduce turbidity, their positive charges make them toxic to aquatic organisms when dissolved in water. Consequently they should not be used as flocculants in stormwater that runs off

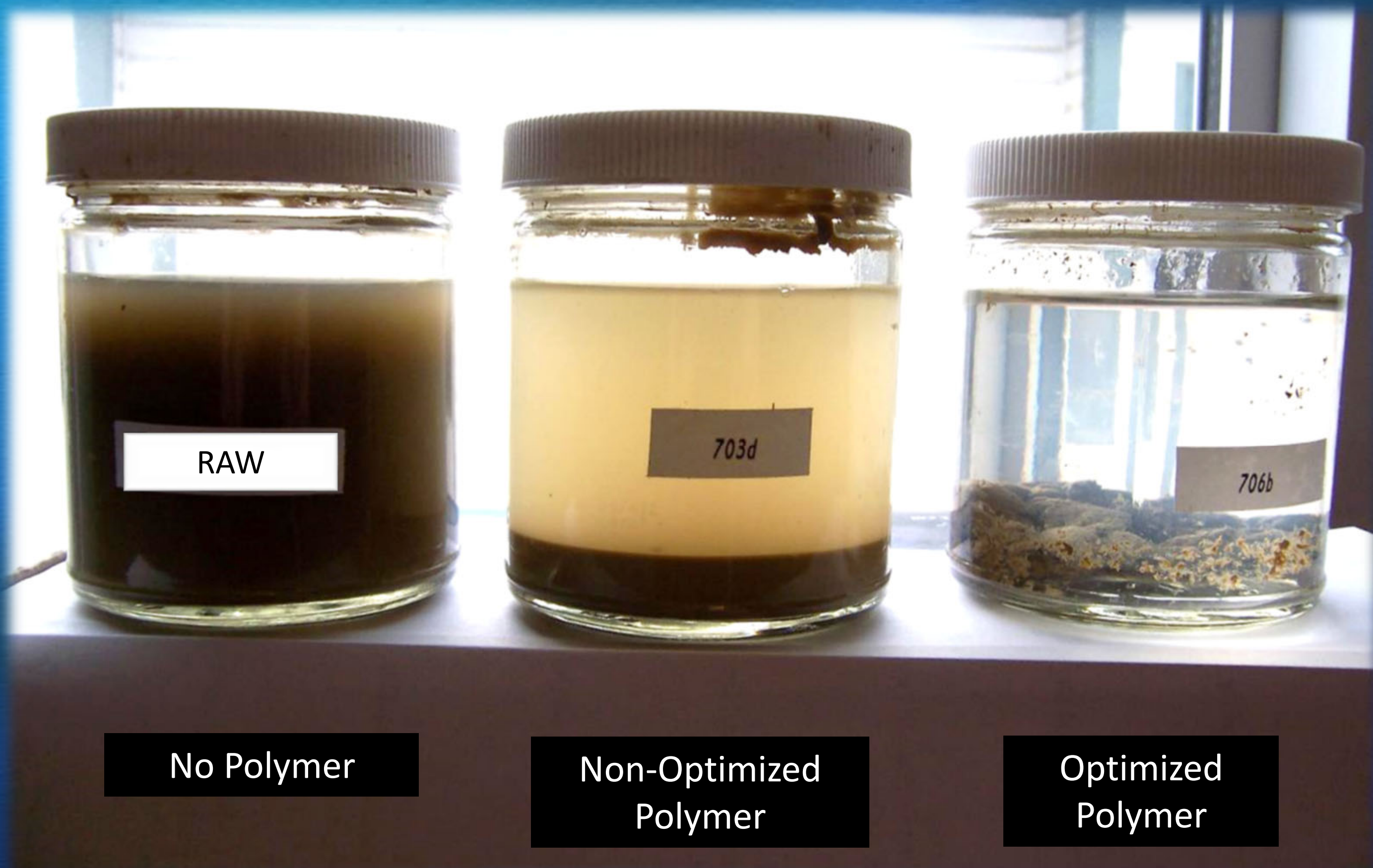
Office of Water, 4203M
www.epa.gov/npdes/pubs/polymerfloc.pdf
www.epa.gov/npdes/stormwater/menuofbmps

October 2013

Three Rules of Polymer Use:

1. Site Specific Testing
2. Full Mixing and Reaction Time
3. Correct Dosage

Polymer Matched To Soil/Water



Performance Based Lab Results

Smith Samples

Sample Location 2/15/2013	Description Sample Type	APS Application Floc Log Type	Results and Special Instructions Reaction Time / NTU Reading
Smithville, Inc. 1111 One Way Drive Anyplace, FL 12345 321-867-5309 jsmith@aol.com	**Water Sample** pH: 6.88 NTUi: 3486 Hardness: 120 CaCO3	706b **Powder** 712	40 - 45 sec. with filtering / 24.9
	Soil Sample pH: 7.21 NTUi: 2742 Hardness: 50 CaCO3	706b **Powder** 712	40 - 45 sec with filtering / 9.20

Note: For detailed instructions and application rates, please refer to the Polymer Enhanced Best Manaagement (PEBMP) Application Guide which is located on the bottom right hand corner of our website at www.SiltStop.com.

Floc Logs are designed to work in flowing water conditions. Mixing / reaction times will be very important when using the Floc Log listed above. **Mixing must be continuous and in contact with the Floc Logs for the time stated to obtain the best results.** A mixing ditch, pipe or flume system may be used with either a pump or gravity flow to meet this requirement. Particulate formed may be captured by filtering through or across a series of jute matting after the mixing and reaction has been completed. (Please see page 42 of the PEBMP for more on Particle Collection.) The dosage rate should be 50 to 60 gpm per Floc Log placed in series or row.

Stabilization of the soil at the source may be obtained by spreading the site-specific Silt Stop powder onto the soil surface (can be mixed with other additives such as seed, fertilizer, etc.), then covering the soil with open-weave jute, coconut matting, mulch, or straw. This will perform as a stabilizer for reducing soil and clay movement into the runoff water, as a tackifier to hold the soil/organic matrix in place, as well as providing surface area for attachment of flocculated sediment. For detailed application rates and instructions, please see the Soil Stabilization section beginning on page 5 of the PEBMP.

Areas where high water velocity may occur (ditch lines, swales, etc.) should be "soft armored" by placing jute or coconut matting flush to the ground surface then spreading powder (dry) over the jute or coconut matting (please refer to PEBMP page 5-10). This will greatly reduce erosion in these areas. When used with the Silt Stop powder, soft armoring binds the soil particles to the matting, stopping them from eroding and entering the water system.

We recommend using both systems for best results.

Applied Polymer Systems, Inc. 519 Industrial Drive Woodstock, GA 30189 www.siltstop.com

Written Guidelines

Determine PAM-Blend

REPORT FOR ACUTE TOXICITY TESTING OF
APPLIED POLYMER SYSTEMS, INC.
SILT STOP PRODUCTS

NORCROSS, GEORGIA

TEST PERIOD: OCTOBER 3-18, 2000

Prepared for:

APPLIED POLYMER SYSTEMS, INC.

Norcross, Georgia

October 2000

Toxicity Test Results

Types of Material:

- Emulsions
- Powders
- Flocculant Logs

PAM Flocculant Logs

- 9 pounds material in coconut netting w/rope
- Anionic Polyacrylamide (main ingredient)
- Block dissolves in flowing water
- Formulations target specific soil lithologies
- May use one or more PAM formulations in treatment train
- Trade Name: “Floc Logs”

Pipe Mixing Systems

Flocculant Logs Placed Directly Inside Pipe For Maximum PAM Mixing And Reduced Treatment System Footprint

Passive Dosing In Storm Drain System

Stormwater Pipe Treatment System
O'Hare Airport, Chicago

O'Hare Airport South Basin-75 Million Gallon Volume

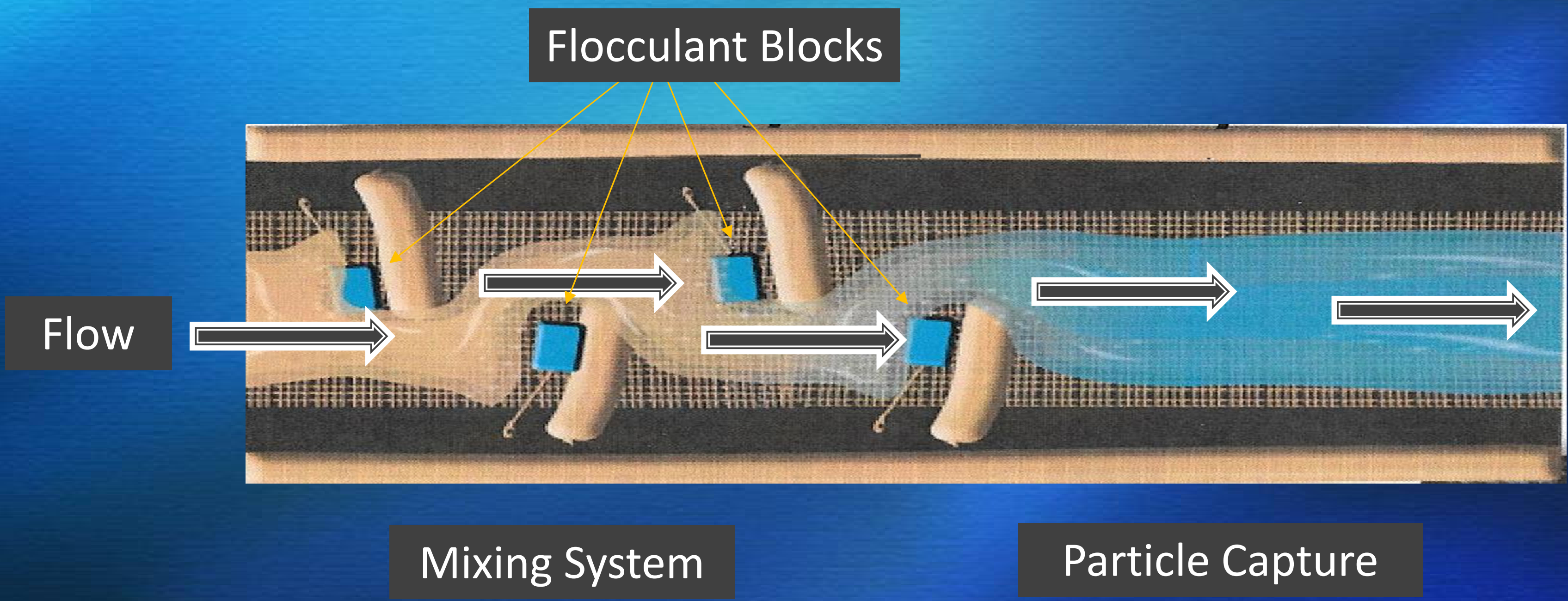
Flocculant Logs Placed In 66" Pipe

Turbid canal before PAM treatment

Direct Flow Over 2 Flocculant Logs

Canal 24 hours after PAM treatment

Dewatering Ditch Mixing System



Ditch Mixing Treatment System

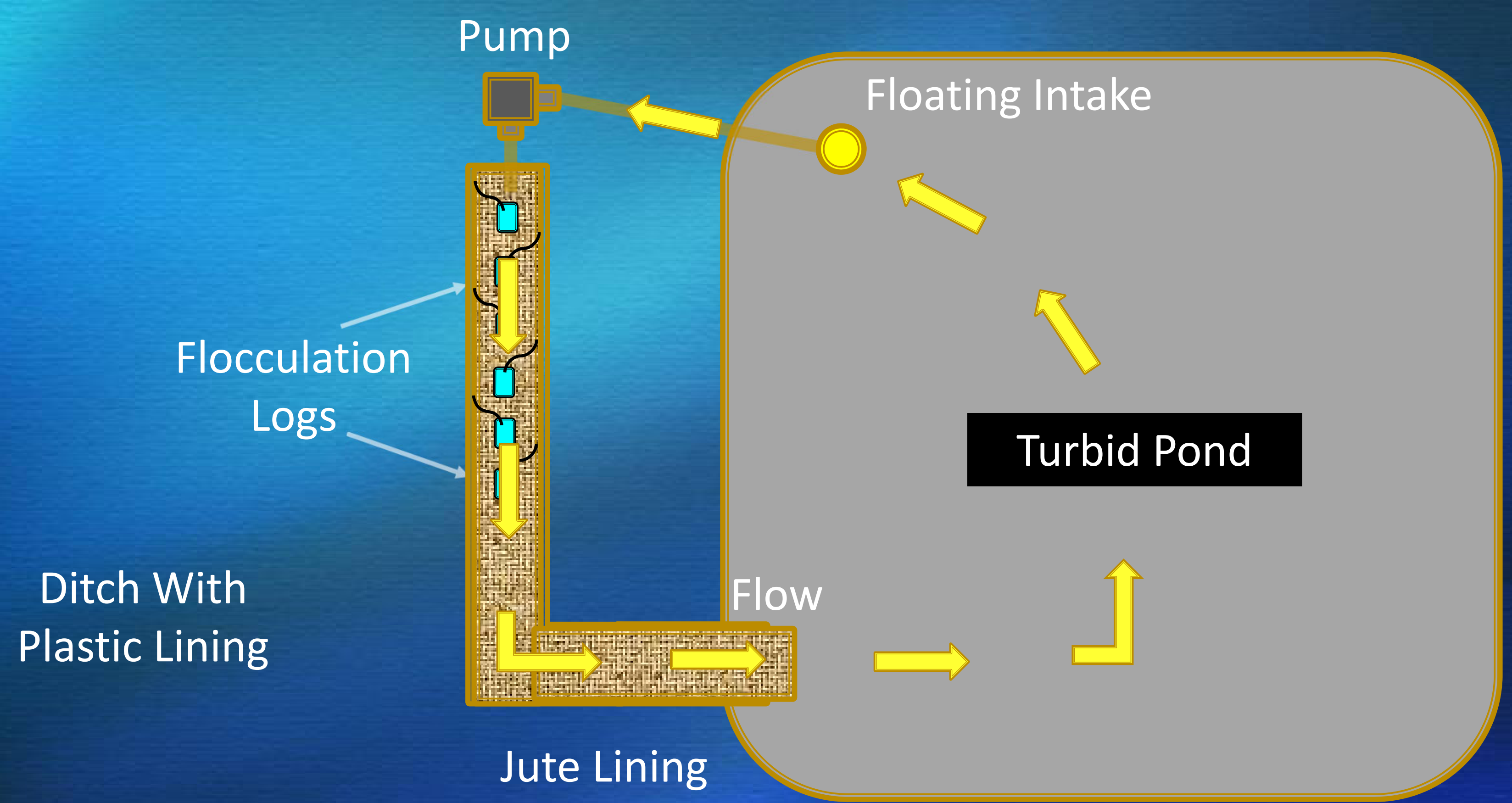
Plastic –lined Ditch Treatment System

Influent Pond Water > 800 NTUs

Final Discharge 2.1 NTUs

Turbidity Removal 99%

Recirculating PAM Treatment Ditch System



Installation of Recirculating Mixing Ditch

Trench Excavation

Plastic Liner

Jute Lining For Particle Capture

Flocculation Blocks

Particle Capture w/Jute

Charging The System With Granular PAM

Pump Start-up

System Operation Video

Performance:

Pond Volume = 2.2 million gallons

Pump Rate = 300 gpm

Pump Duration = 6 days

Initial Turbidity = 120 NTUs

Target = 25 NTUs

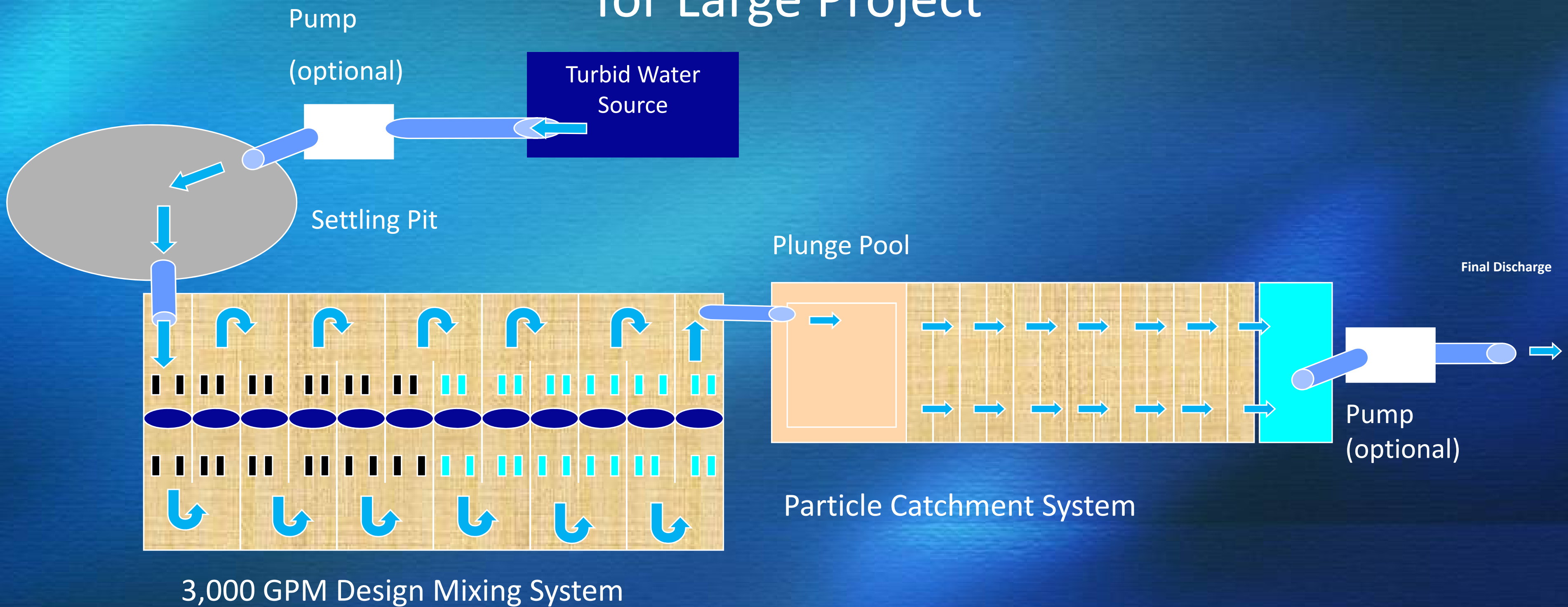
Final Turbidity = 8 NTUs

93% Reduction

Flocculant Logs Used In Split Pipe Dewatering System On Pavement

Baffle Grid Mixing System

Generic Baffle Grid Dewatering System for Large Project



Baffle Grid System Overview

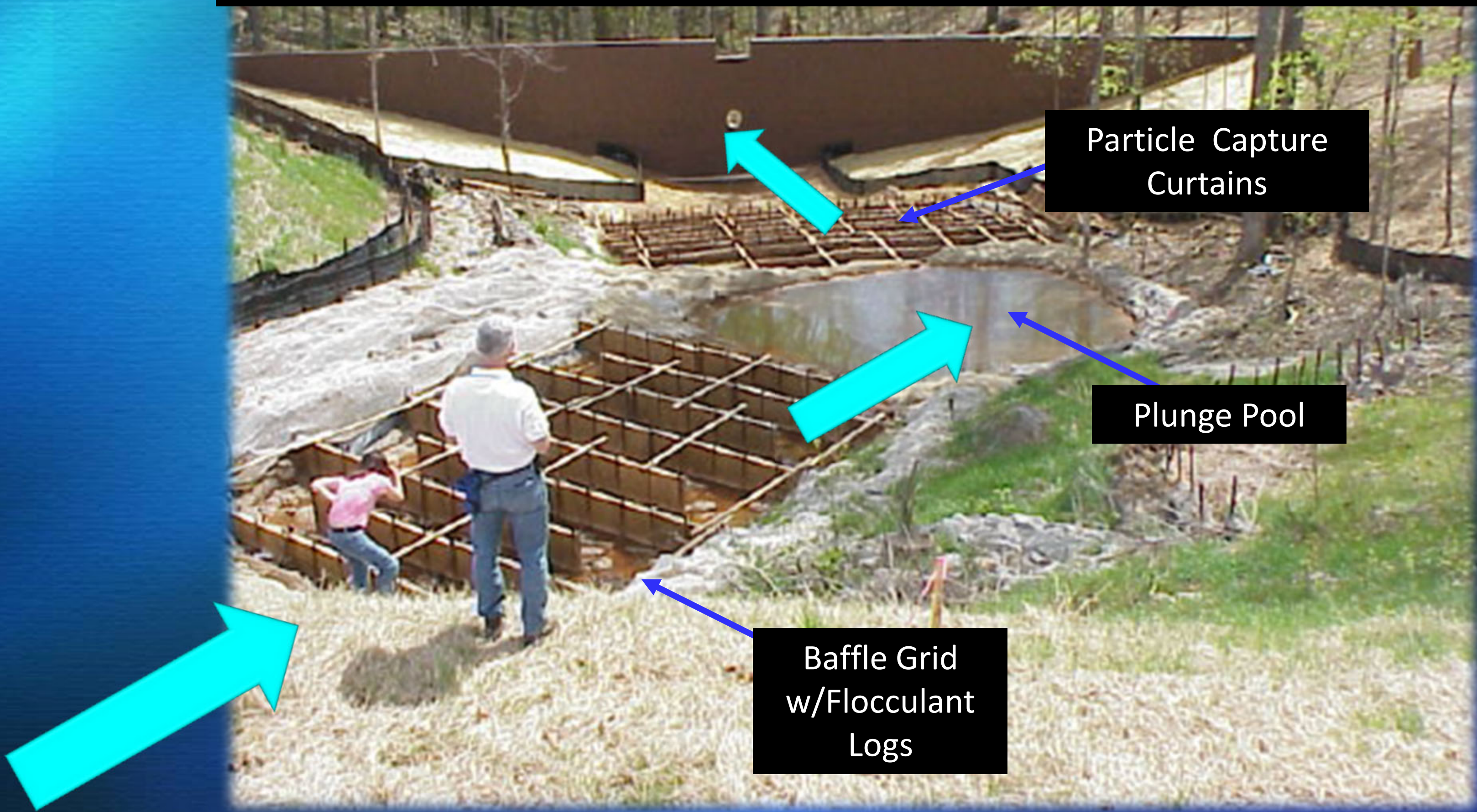
****Not To Scale**

Baffle Grid Mixing System

Polymer Mixing

Particle Capture

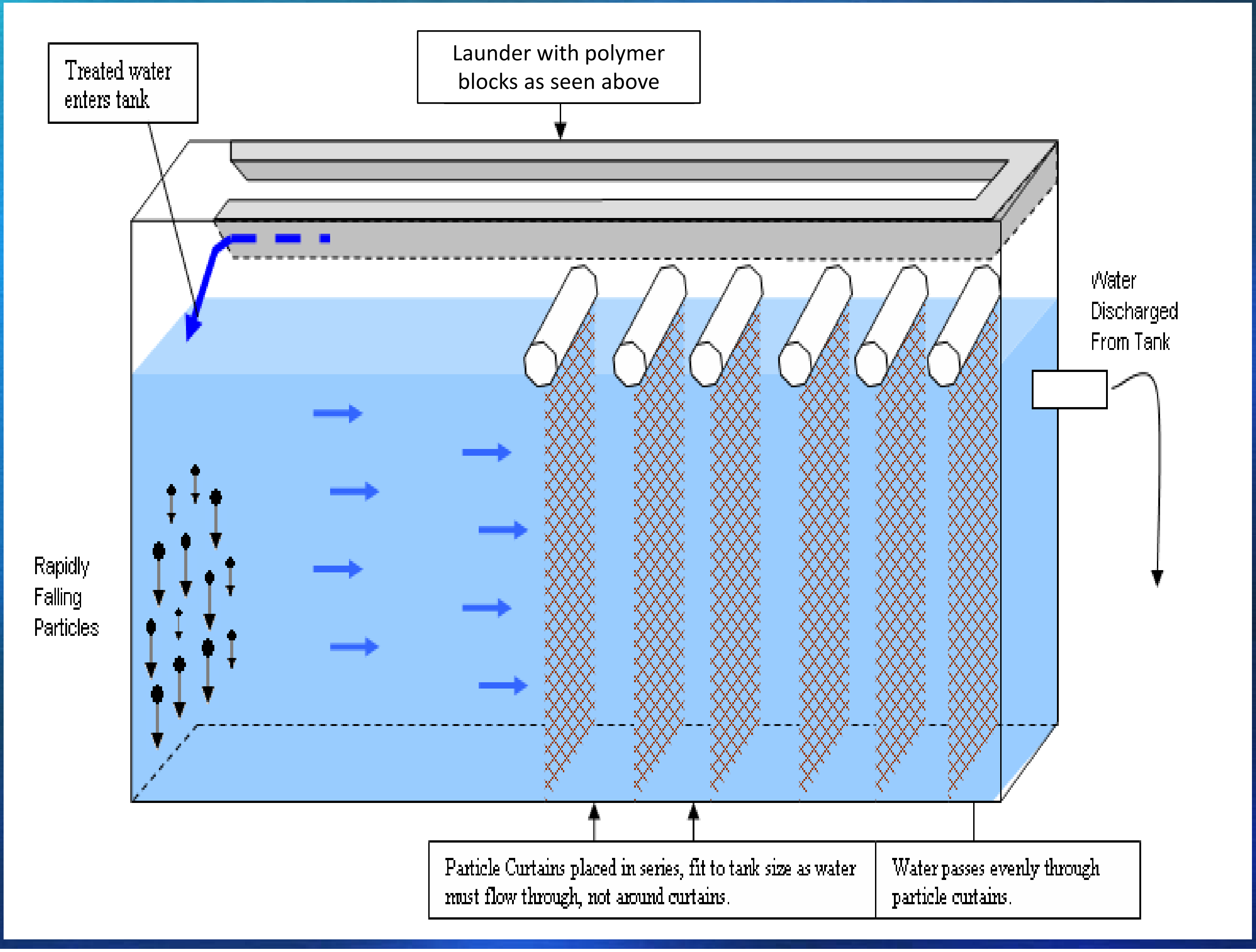
Baffle Grid Mixing System Used On Apartment Project For Three Years

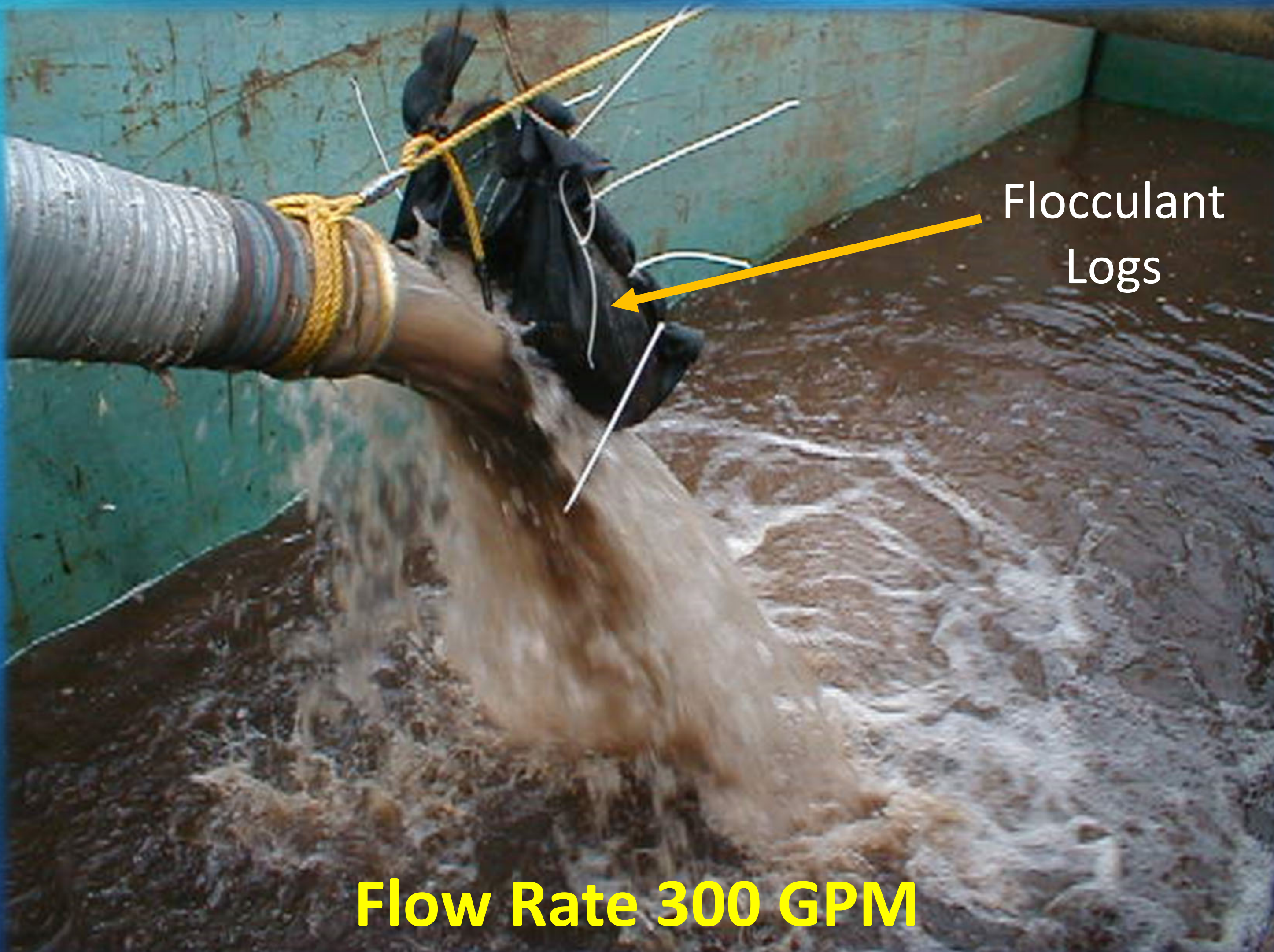


Container PAM Mixing System Used On Boat Mariana Dredge Project

Container PAM Mixing System

Particle Curtains For Floc Capture In Flowing Water

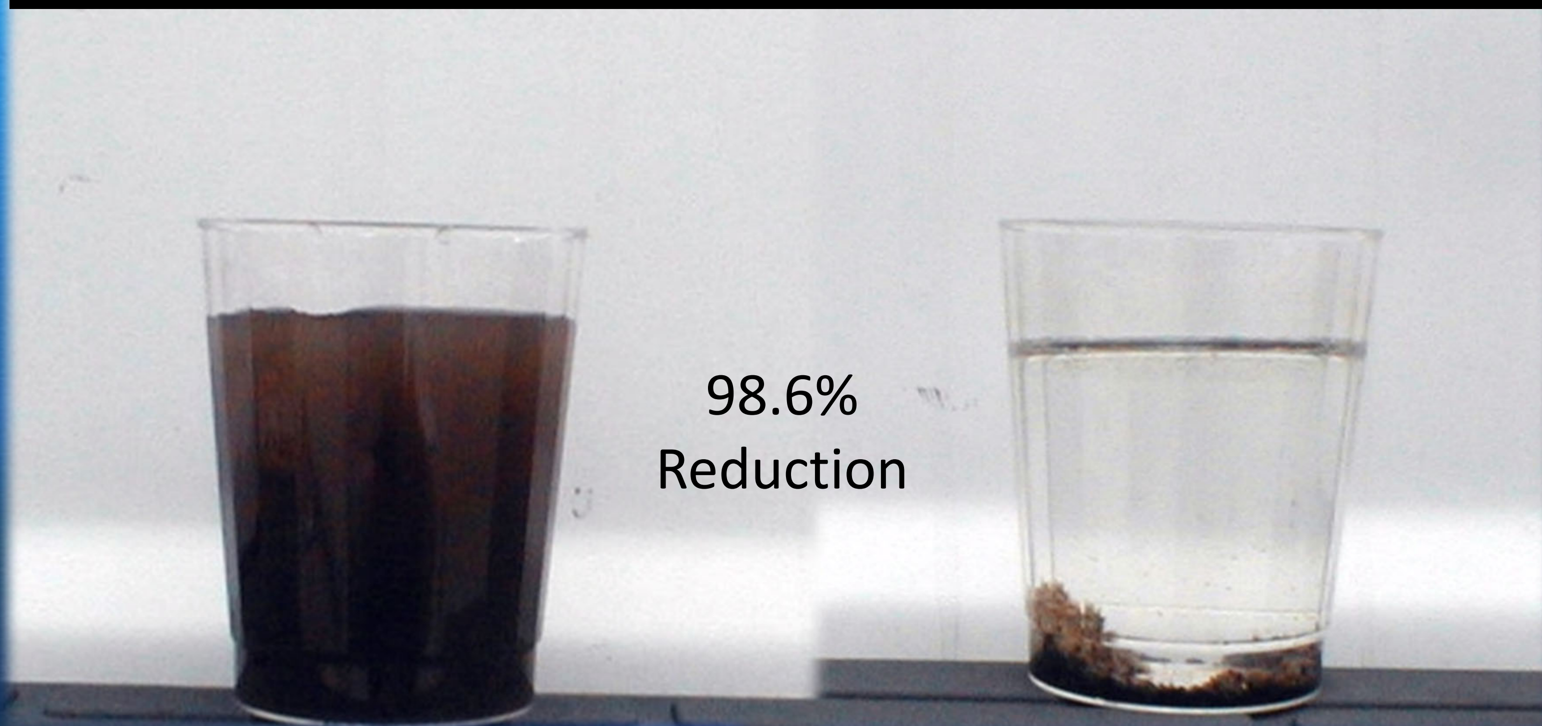



Flocculant
Logs
Flow Rate 300 GPM

5% Solids With Muck And High Humic Acid

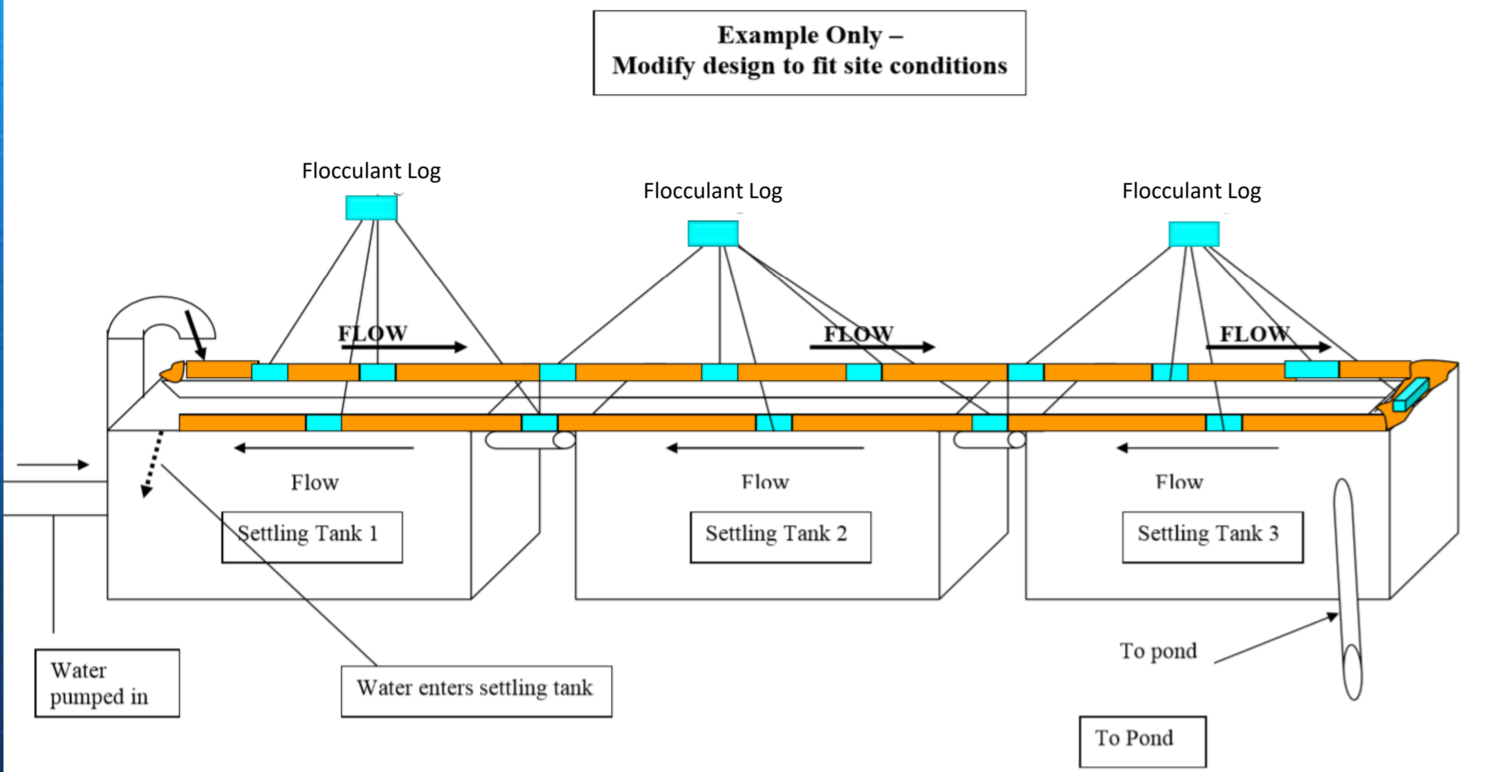
Initial Turbidity 500-1500 NTUs

Final Turbidity 20 NTUs



Container PAM Mixing System

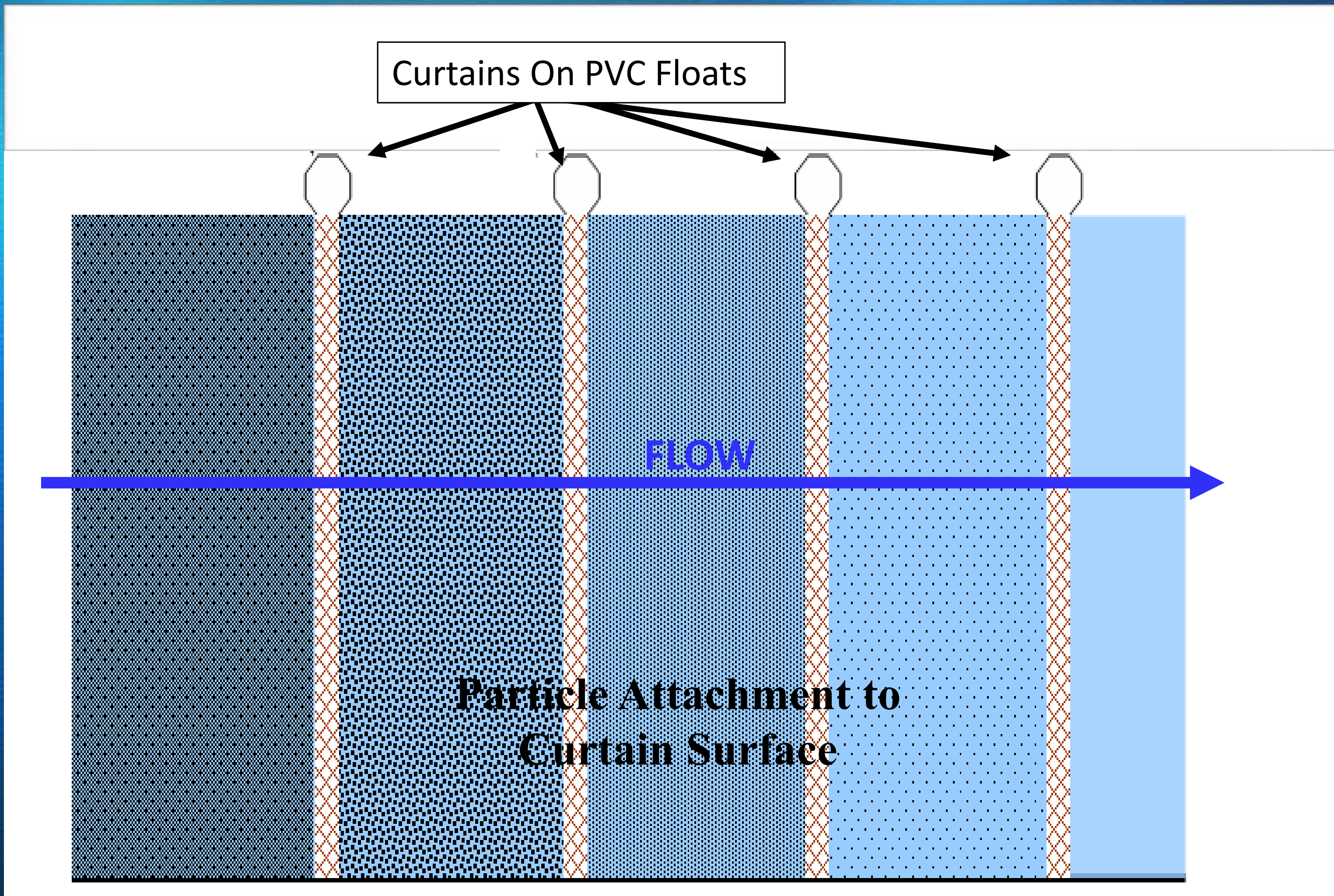
Water Clarification
Treatment Split Pipe
For use with baker tank



Mixing launder system using three tanks in series

Tank one acts as a settling basin and captures large particulate

Tanks 2-3 use particle curtains to capture fine particulate



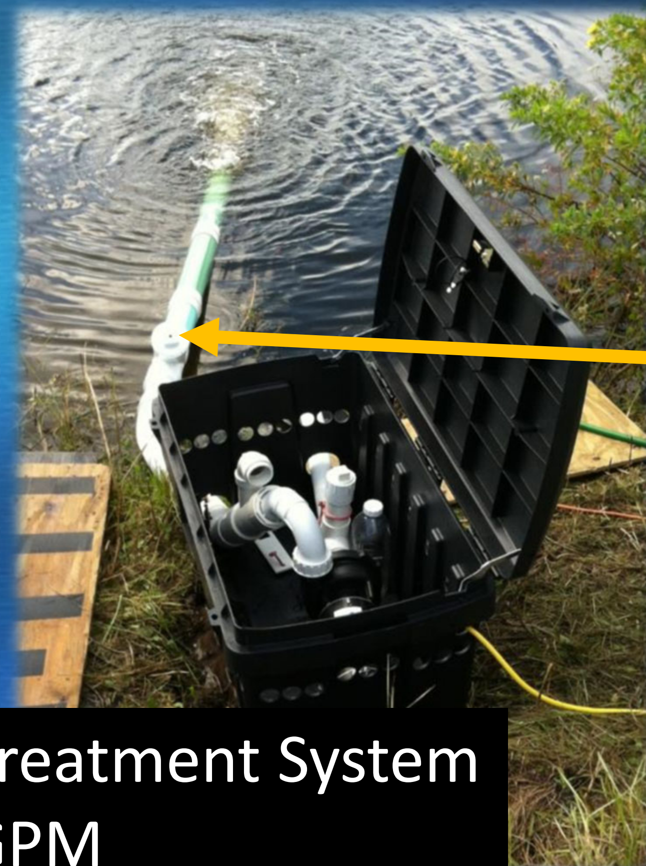
Particle Curtain System

Flowing Water BMP
Floating Particle Curtains
Placed Downstream Of Work Area

In-stream Capture Of PAM Floc In Flowing Water Systems

Pipe Mixing Systems

Pipe Mixing Systems



L.I.P.V.A.C.S. PAM Treatment System
220 GPM
Self-contained Electric Pump

Pipe Mixing Systems

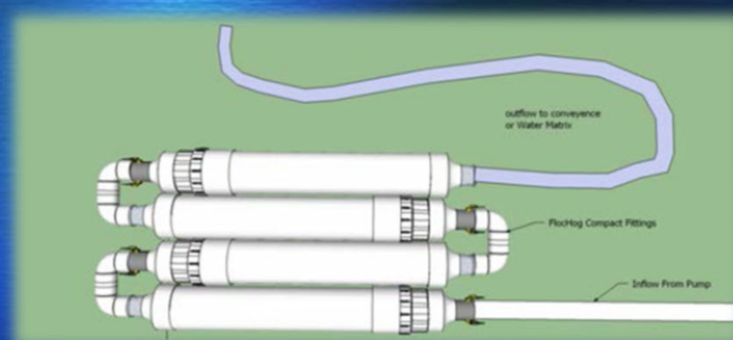
Pipe Mixing Systems

Initial Turbidity 120 NTUs
Final Turbidity 6 NTUs
95% Reduction

Pipe Mixing Systems

500 GPM Flow

Additional Units Can Be Linked Or Stacked



Pipe Mixing System (4 & 6-Inch Pumps)

500 -1200 GPM Flow
Additional Units Can Be
Linked In Series

I-4 Widening Project, Orlando, FL

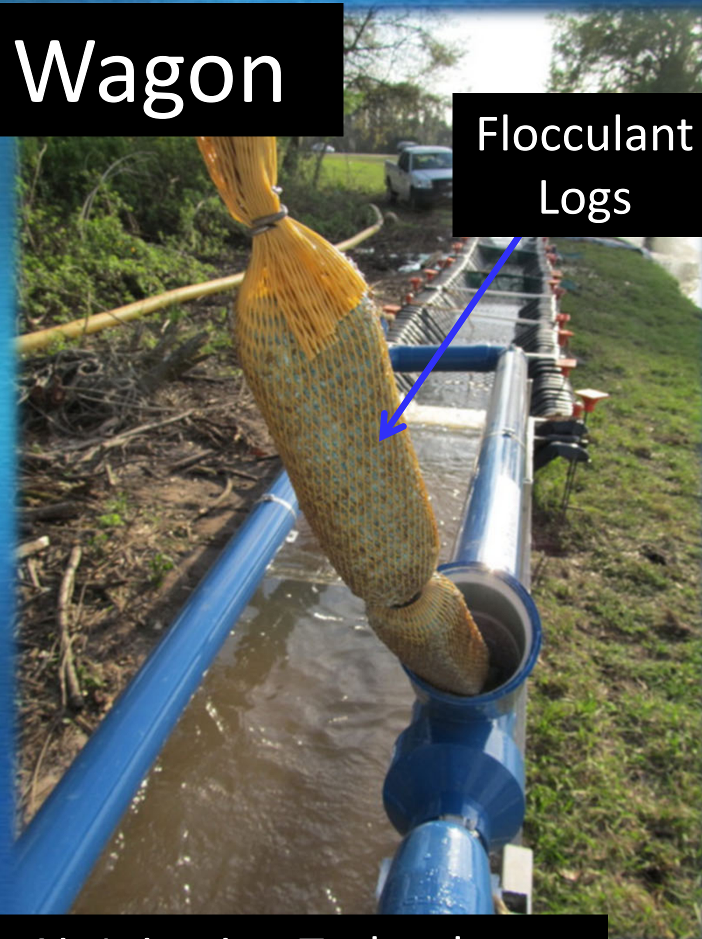
Link Manifold System

Initial Turbidity = 800 NTUs
Final Turbidity = 17 NTUs
Reduction = 98%
Pump Rate 1500 GPM

Dewatering hydro-electric dam project in Nova Scotia, Canada


SAND

Water Wagon



Double Mixing Chambers Using Air Injection Technology

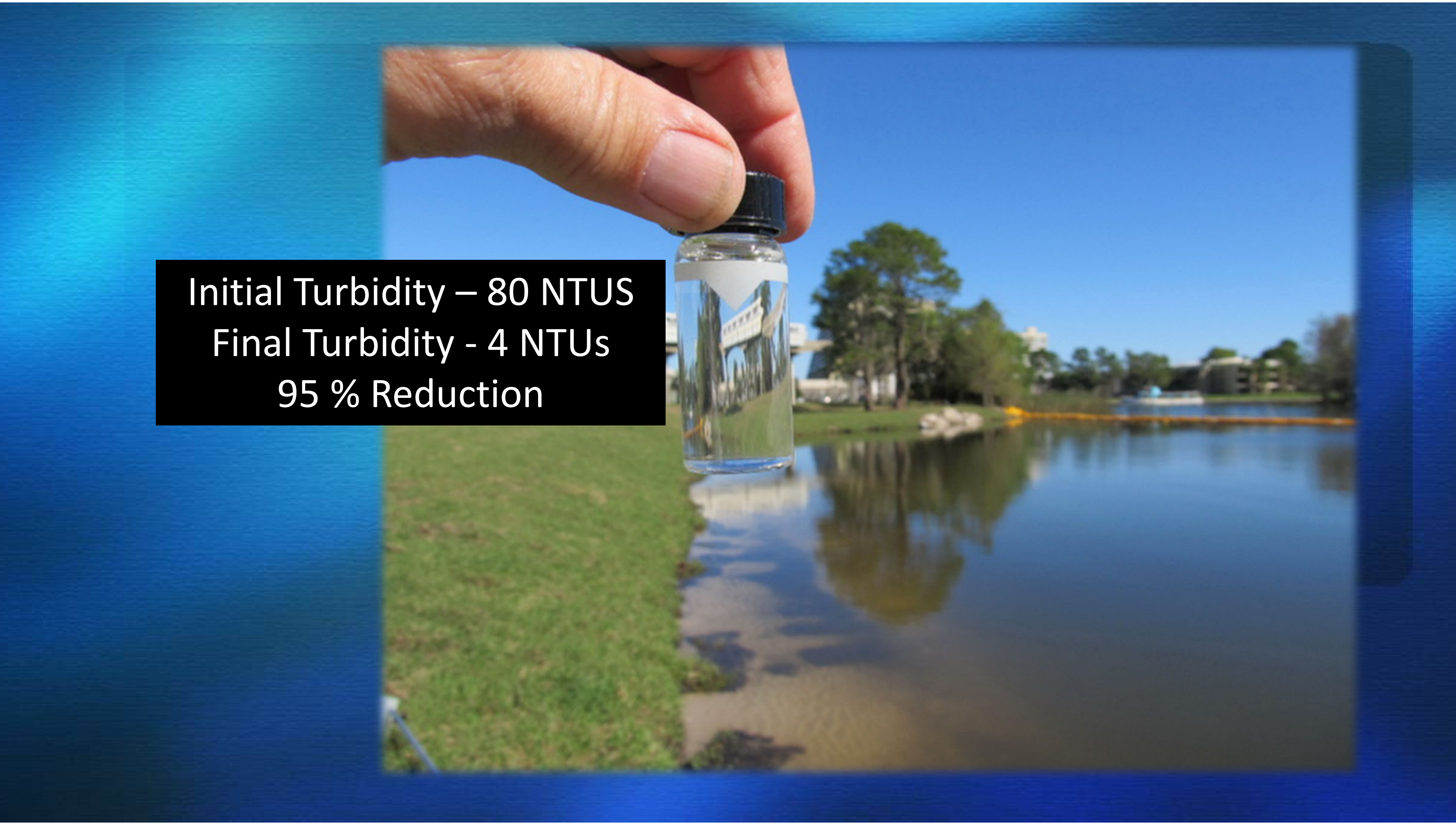
*Extremely Efficient PAM Mixing System

Pipe Mixing System

Newly Constructed Cove On Highly Sensitive Lake.

Boomed Area Turbidity Varied 65-85 NTUs,

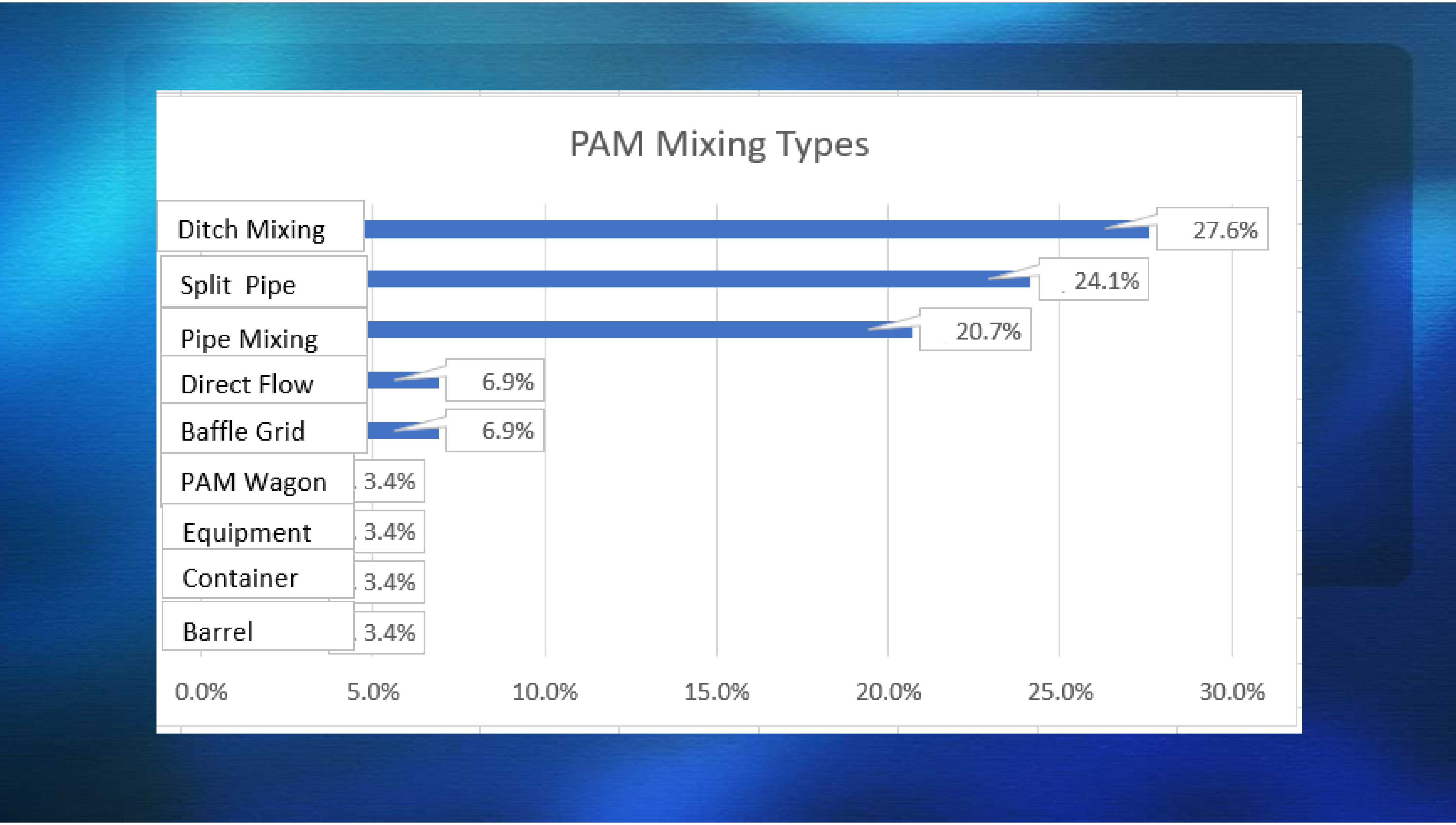
Lake Turbidity 3-5 NTUs

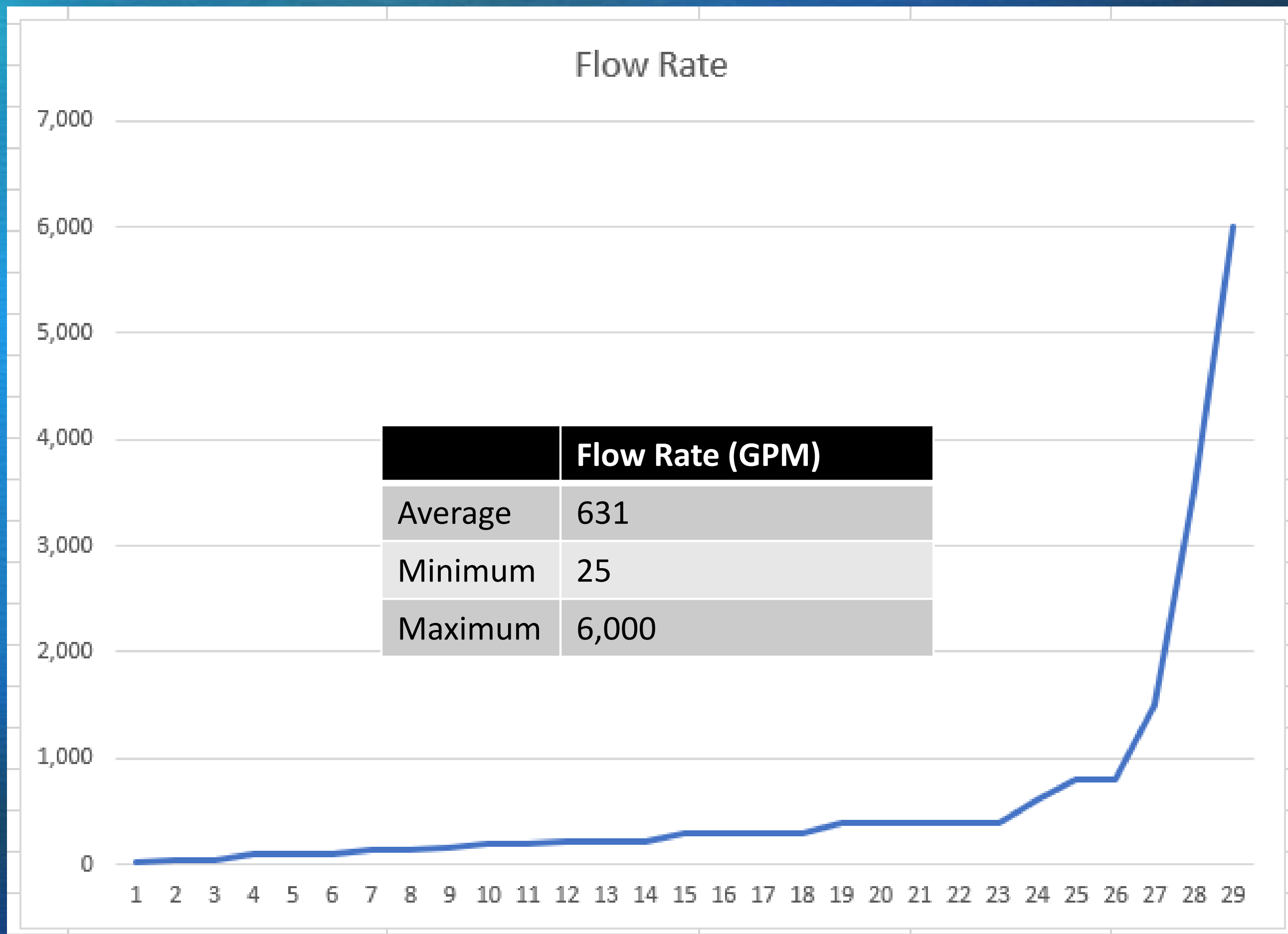

Initial Turbidity – 80 NTUS
Final Turbidity - 4 NTUs
95 % Reduction

Project List and Information

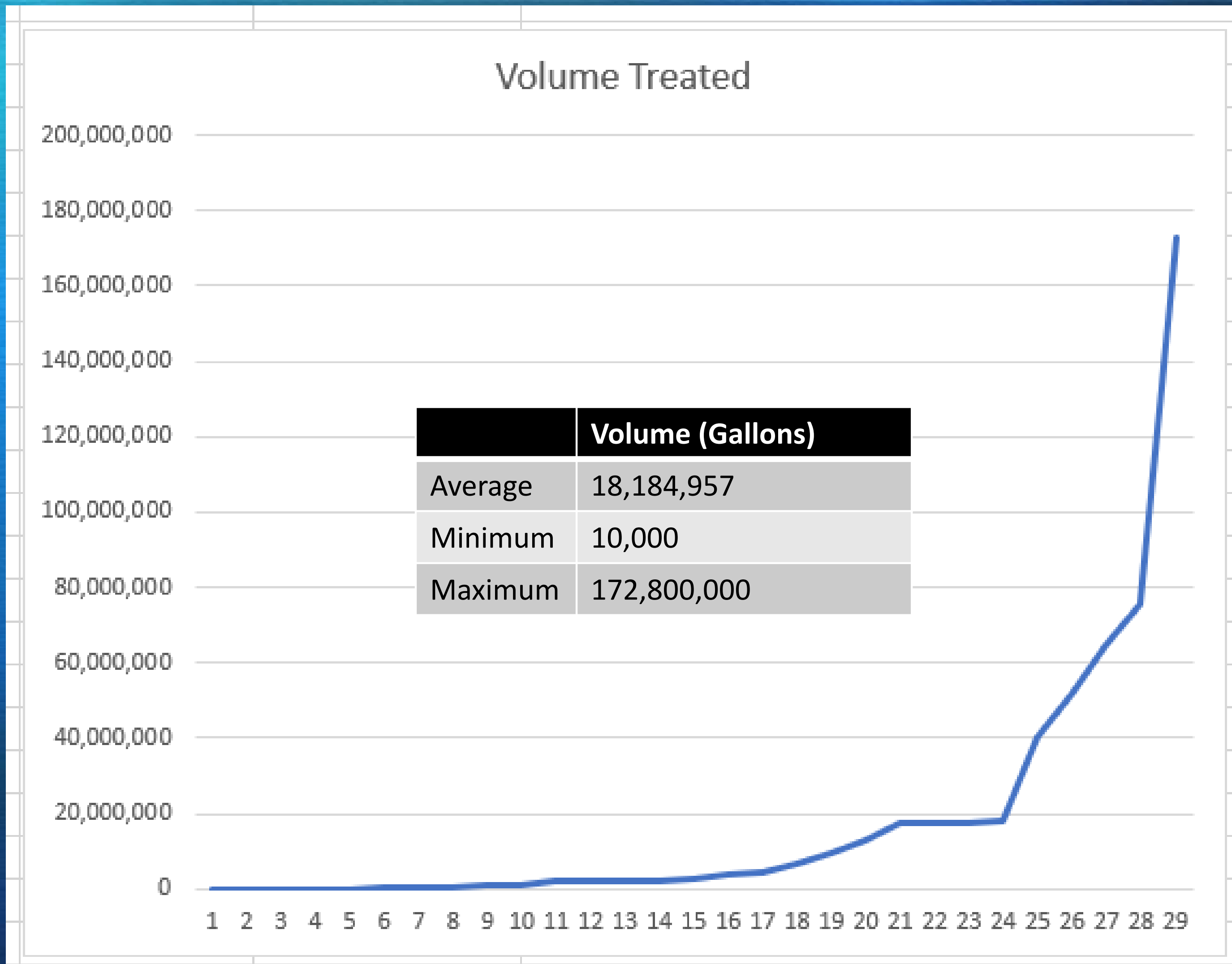
Project Type	Date	Location	PAM Type	Initial Turbidity (NTUs)	Final Turbidity (NTUs)	% Reduction	Flow Rate (GPM)	Volume Treated (Gallons)	Soil Type	Comments
Pond Dewatering	Jun-97	Fulton County, GA	Ditch Mixing	800	2	99	400	4,032,000	Clay	Basic set-up
Pond Dredge	Apr-98	Holly Springs, GA	Ditch Mixing	850	15	98	130	10,000	Clay	New subdivision pond
Pond Dredge	Apr-98	Holly Springs, GA	Ditch Mixing	400	20	95	130	14,000	Clay	New subdivision pond
Boat Marina Dredge	May-98	RCID, FL	Pipe Mixing-LIPVACS	300	16	95	220	316,800	Clay	Particle curtain capture used
Boat Marina Dredge	Jan-99	RCID, FL	Container Mixing	1,500	15	99	300	3,024,000	Muck	Turbidity treated post dredge
Railway Corridor	Jun-99	Greenbush, MA	Split Pipe	900	22	98	300	12,960,000	Clay	Frac tanks used as settling basins
Pond Dredge	Mar-00	Fulton County, GA	Baffle Grid	1,830	13	99	800	17,280,000	Clay	Residential pond turbidity from construction
Canal Dredge	Mar-01	Bonita Springs, FL	Equipment Motion	1,000	7	99	100	432,000	Muck	Discharge to OFW
Pond Turbidity Treatment	Mar-02	RCID, FL	Pipe Mixing-LIPVACS	500	11	98	220	2,016,000	Clay	Water line blow-out into pond
Construction Dewatering	Apr-02	Chicago, IL	Pipe Mixing	1,300	10	99	400	17,280,000	Clay	Soldier Field construction
Construction Dewatering	Apr-04	Antioch, IL	Baffle Grid	8,960	2	100	100	4,320,000	Clay	Walmart project
Pond Dredge	Aug-04	Daytona, FL	Ditch Mixing	270	2	99	300	18,144,000	Muck & Clay	Operated during hurricane event
Construction Turbidity	May-05	Alachua County, FL	Barrel Mixing	100	15	85	50	10,800	Clay	Rehab of recreational park in springs area
Roadway Pond Dewatering	Jul-05	Tampa, FL	Split Pipe	1,000	19	98	600	40,000,000	Clay	Smart Ditch mixing system used
Condominium Construction	Dec-05	South Hadley, MA	Split Pipe	600	10	98	150	6,480,000	Clay	Winter operation
Pond Turbidity Treatment	Apr-06	Northeast, GA	Pipe Mixing-LIPVACS	967	14	99	220	9,504,000	Clay	Pipeline construction turbidity in private pond
Mine Roadway Dewatering	Jul-06	Bartow, FL	Ditch Mixing	800	17	98	800	51,840,000	Clay	Continual pumping during rainy season
River Cove Dredge	Apr-07	Kentucky Lake, TN	Ditch Mixing	600	21	97	3,500	75,600,000	Clay	SRB and dispersion field used
Tunnel Dewatering	Apr-07	Gwinnett County, GA	Split Pipe	1,000	1	100	400	17,280,000	Clay & Limestone	Mixing launder with three tanks & particle curtains
Pond Dewatering	Apr-07	Vero Beach, FL	Split Pipe	95	4	96	200	2,036,160	Clay	Discharge to OFW
Canal Dredge	Apr-08	RCID, FL	Split Pipe	300	9	97	100	1,008,000	Muck & Clay	Particle curtain capture used
Pond Dewatering	May-09	RCID, FL	Split Pipe	849	19	98	400	2,300,000	Muck	PAM system replaced Alum system due to failure
PAM Wagon Test	May-10	RCID, FL	PAM Wagon	291	12	96	400	960,000	Muck	Prototype test (never went to production)
Geothermal Well Discharge	Jun-10	State College, PA	Ditch Mixing	5,000	2	100	50	144,000	Clay	Particle curtain capture used
Riverbed Restoration	Feb-12	Kalamazoo, MI	Pipe Mixing-Floc Hog	11,000	42	100	6,000	172,800,000	Clay	Oil pipeline rupture required mitigation
Canal Turbidity	Mar-15	RCID, FL	Direct Flow	157	3	98	300	432,000	Marine Shell	Boat cradle support structure failure in canal
Construction Turbidity	Jan-16	Orlando, FL	Pipe Mixing-LMS	800	11	99	1,500	64,800,000	Clay	Ultimate I-4 Project using Link Manifold System
Seawall Construction	Feb-17	Windermere, FL	Direct Flow	65	1	98	25	36,000	Clay	2-inch pump treated boom containment area
Roadway Pond Dewatering	Feb-19	San Antonio, FL	Ditch Mixing	117	10	91	200	2,304,000	Clay	3-inch trash pump used

29 Projects
6 States (locations: FL, GA, TN, IL, PA, MI)
1997-2019

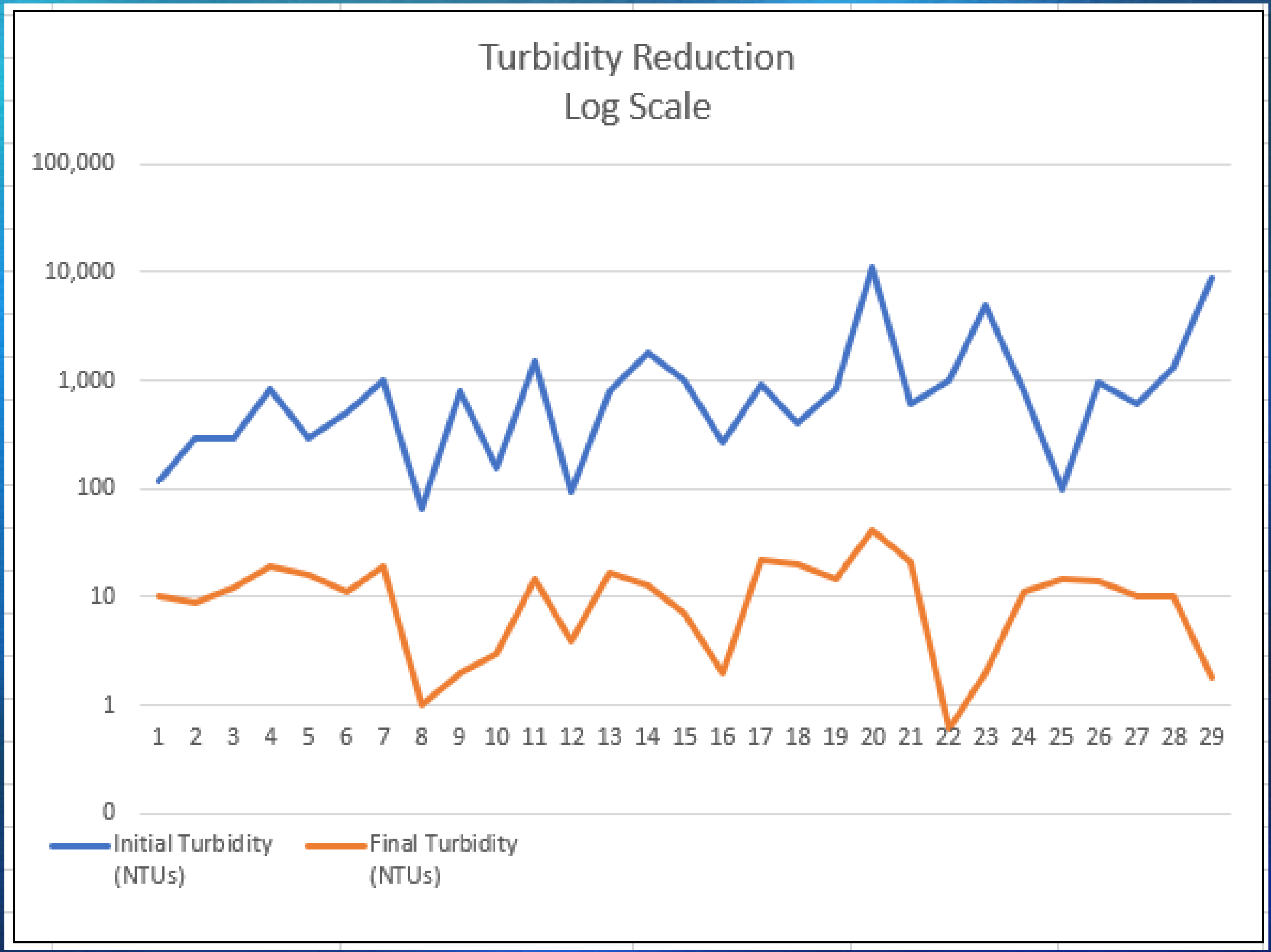

PAM Mixing Types
Ditch Mixing
27.6%
Split Pipe
24.1%
Pipe Mixing
20.7%
Direct Flow
6.9%
Baffle Grid
6.9%
PAM Wagon
3.4%
Equipment
3.4%
Container
3.4%
Barrel
3.4%
0.0%
5.0%
10.0%
15.0%
20.0%
25.0%
30.0%



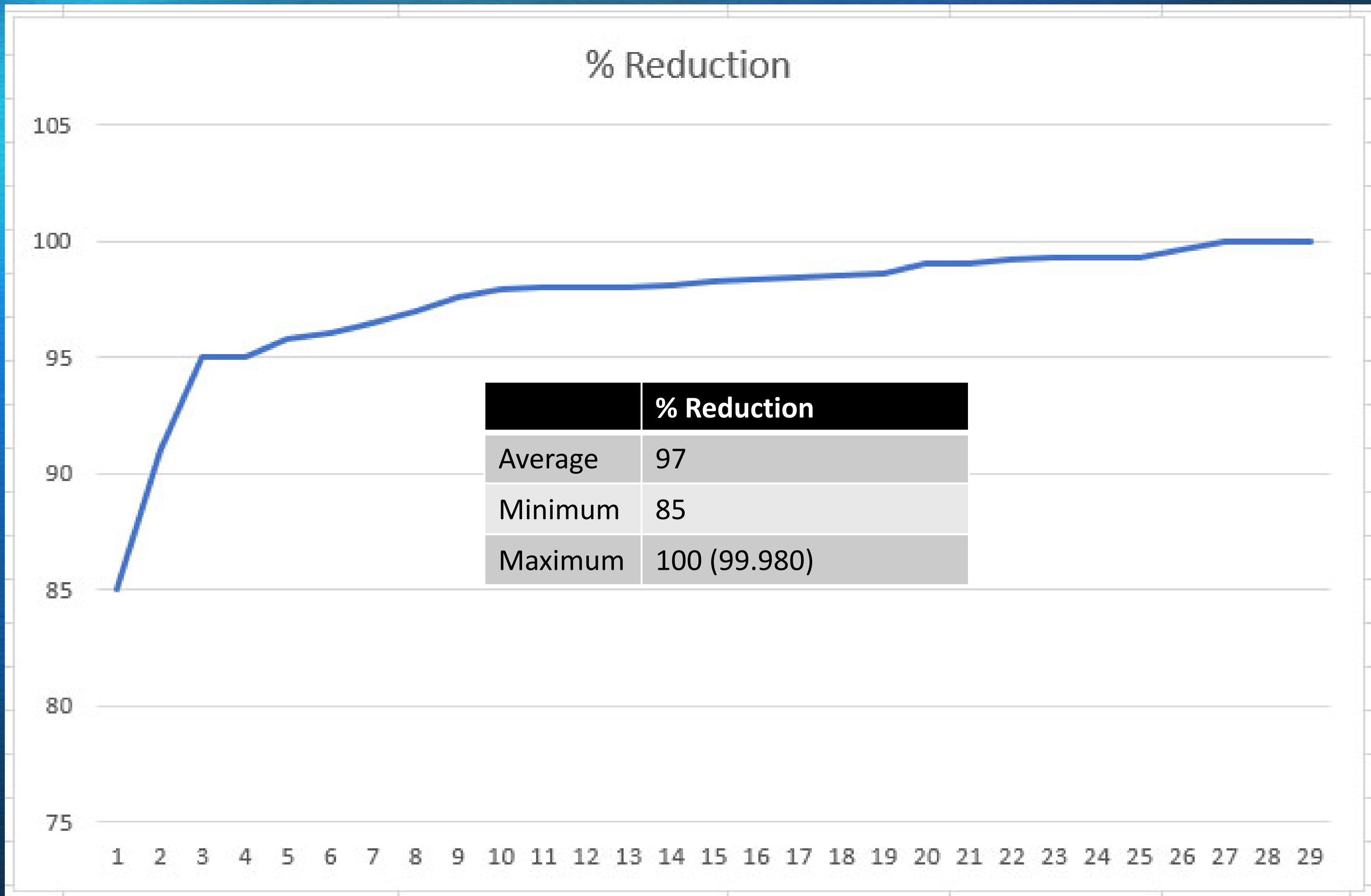
	Flow Rate (GPM)
Average	631
Minimum	25
Maximum	6,000



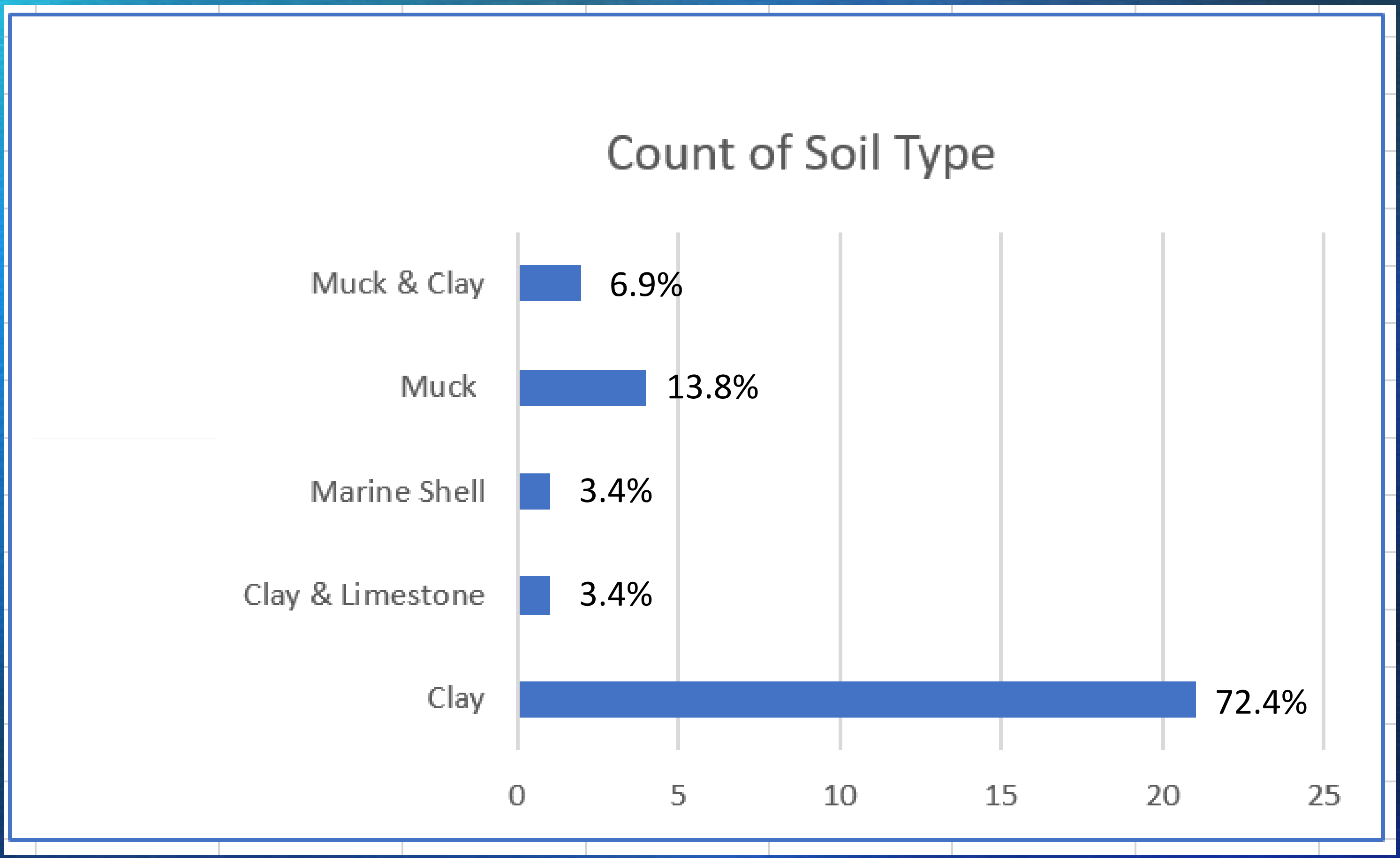
	Volume (Gallons)
Average	18,184,957
Minimum	10,000
Maximum	172,800,000



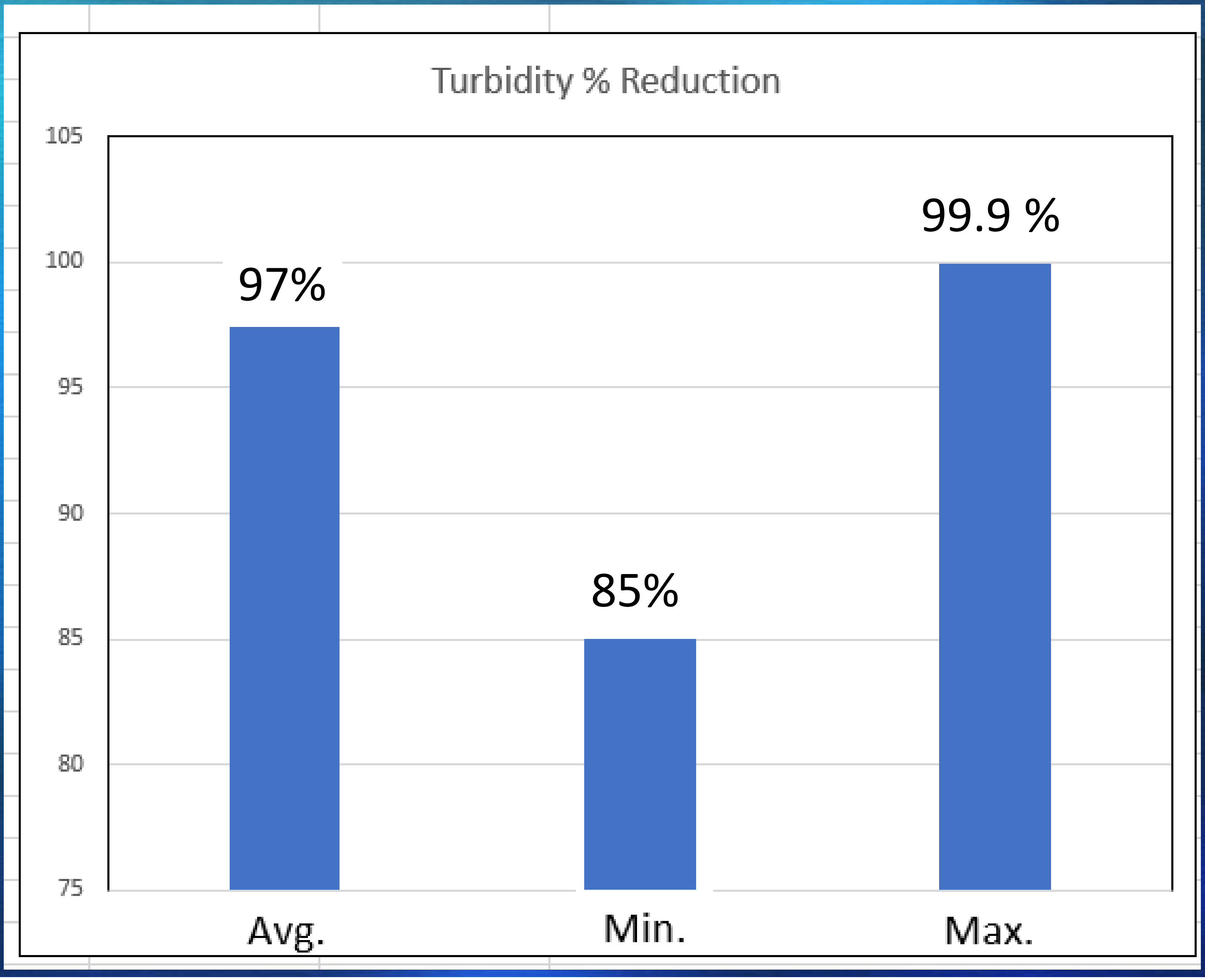
Turbidity Reduction
Log Scale
100,000
10,000
1,000
100
10
1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Initial Turbidity (NTUs)
Final Turbidity (NTUs)



	% Reduction
Average	97
Minimum	85
Maximum	100 (99.980)



Count of Soil Type
Muck & Clay
6.9%
Muck
13.8%
Marine Shell
3.4%
Clay & Limestone
3.4%
Clay
72.4%
0
5
10
15
20
25



Turbidity % Reduction
105
100
95
90
85
80
75
97%
85%
99.9 %
Avg.
Min.
Max.

Conclusions:

- Polymer Gel Blocks Very Effective At Turbidity Reduction
- Allow For Variation w/Respect To Volume, Flow Rate, Footprint
- Contractor Design/Build Own or Rent/Purchase Turn-key System
- Effective In Multiple Soil Lithologies
- Effective In Varied Climatic Ranges

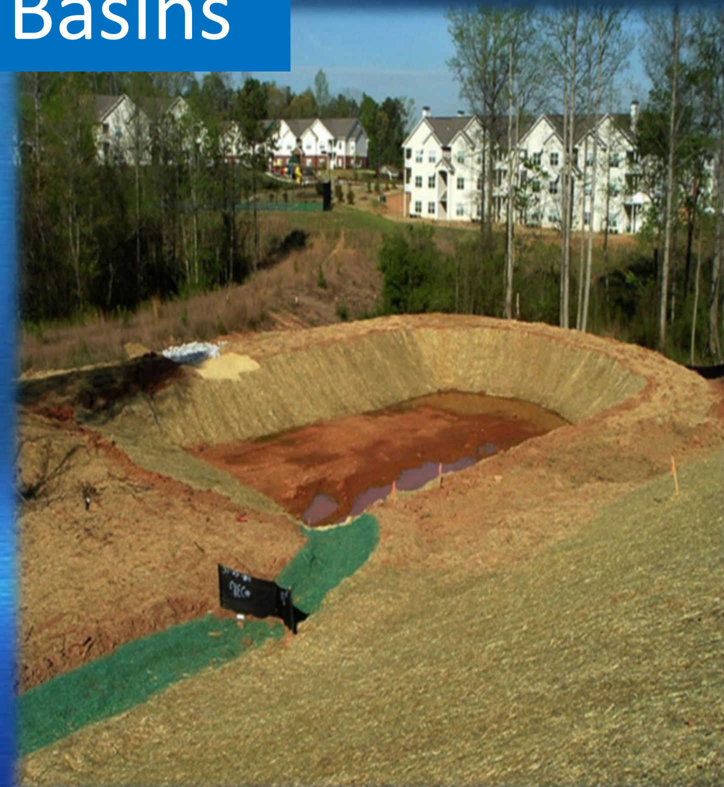
Final Thoughts:

Anionic polymers do not replace good BMPs

Anionic polymers enhance good BMPs

What BMP could we immediately improve?

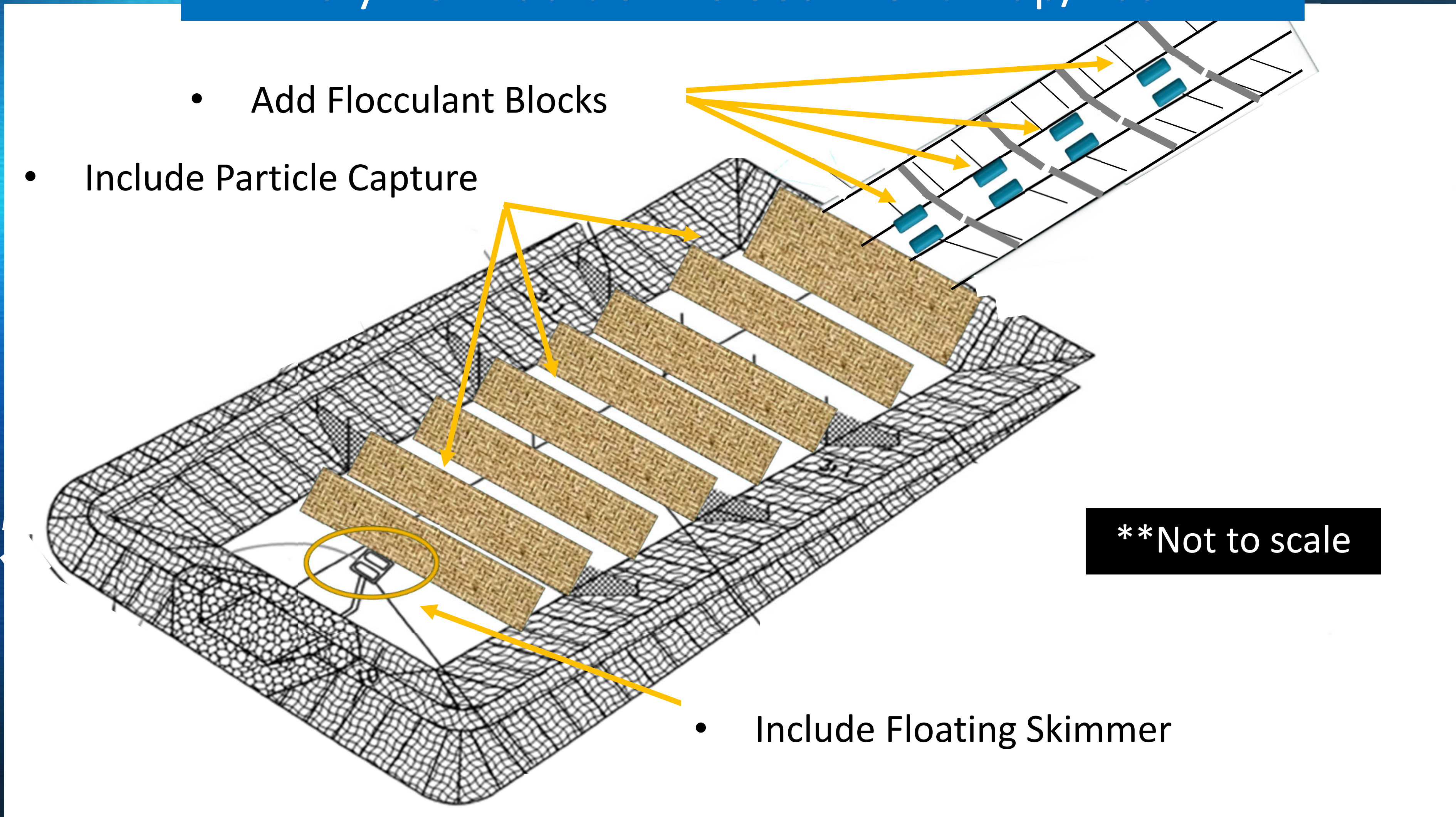
Sediment Traps & Basins



Sediment Basins and Traps With Baffles

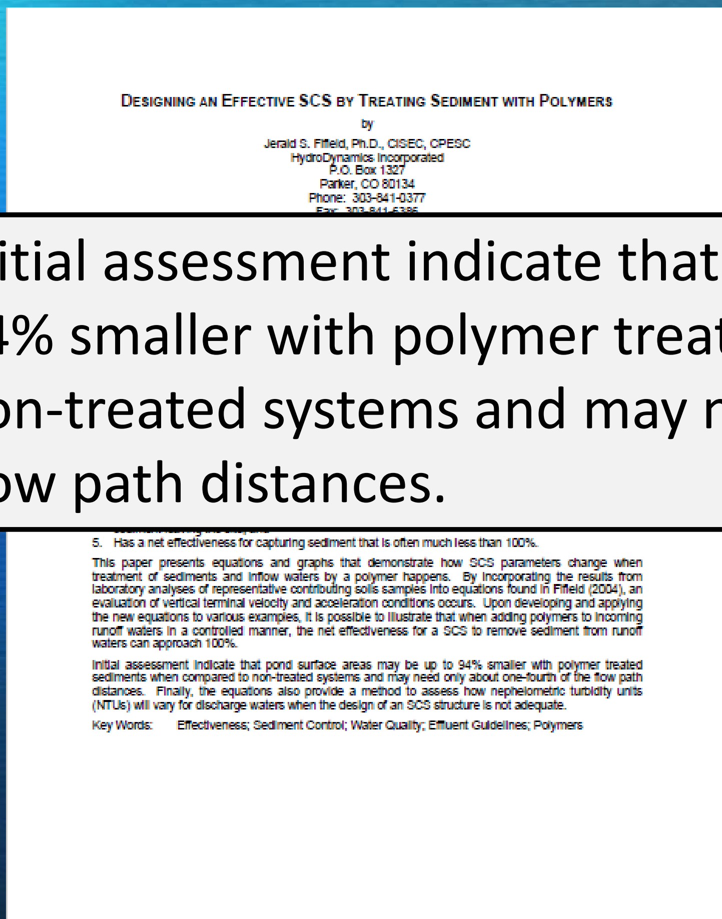



Polymer Addition To Sediment Trap/Basin



Designing An Effective SCS By Treating Sediment With Polymers
Jerald S. Fifield, Ph.D.

Initial assessment indicate that pond surface areas may be up to 94% smaller with polymer treated sediments when compared to non-treated systems and may need only about one-fourth of the flow path distances.



DESIGNING AN EFFECTIVE SCS BY TREATING SEDIMENT WITH POLYMERS

by

Jerald S. Fifield, Ph.D., CISEC, CPESC
HydroDynamics Incorporated
P.O. Box 1327
Parker, CO 80134
Phone: 303-841-0377

5. Has a net effectiveness for capturing sediment that is often much less than 100%.

This paper presents equations and graphs that demonstrate how SCS parameters change when treatment of sediments and inflow waters by a polymer happens. By incorporating the results from laboratory analyses of representative contributing soils samples into equations found in Fifield (2004), an evaluation of vertical terminal velocity and acceleration conditions occurs. Upon developing and applying the new equations to various examples, it is possible to illustrate that when adding polymers to incoming runoff waters in a controlled manner, the net effectiveness for a SCS to remove sediment from runoff waters can approach 100%.

Initial assessment indicate that pond surface areas may be up to 94% smaller with polymer treated sediments when compared to non-treated systems and may need only about one-fourth of the flow path distances. Finally, the equations also provide a method to assess how nephelometric turbidity units (NTUs) will vary for discharge waters when the design of an SCS structure is not adequate.

Key Words: Effectiveness; Sediment Control; Water Quality; Effluent Guidelines; Polymers

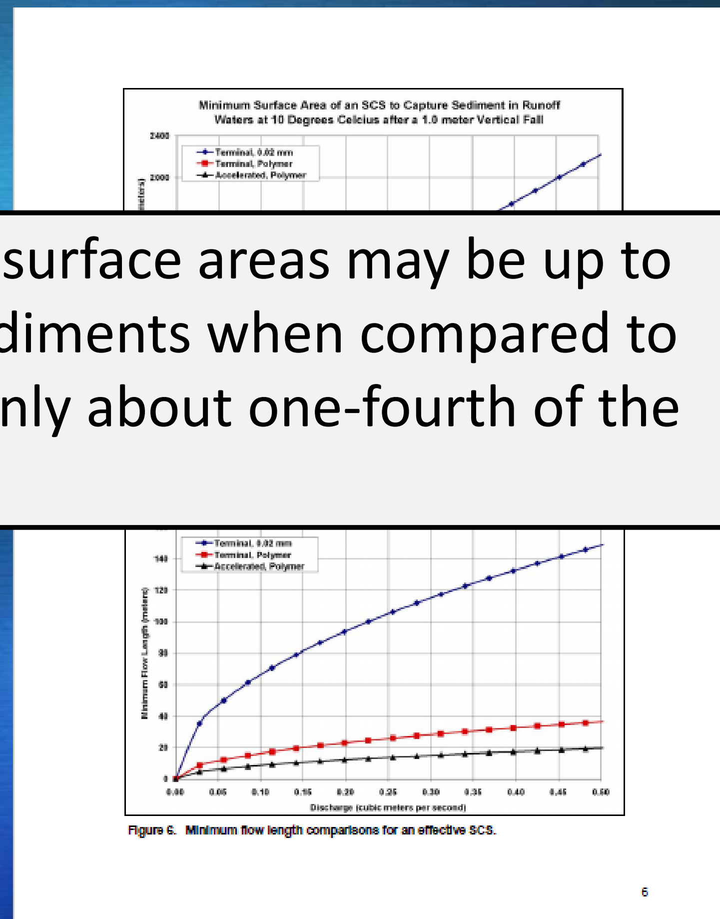


Figure 6. Minimum flow length comparisons for an effective SCS.

Modular Particulate Capture System (Sediment Trap)

Floc Pit Installation

Modular Particulate Capture System

Modular Particulate Capture System

Modular Particulate Capture System

United States Environmental Protection Agency

All products must meet or exceed the requirements of the EPA Construction Generic Permit for chemical treatment of stormwater from construction activities using anionic polyacrylamide
(Effective 2022).

Resource Information

- USEPA
- Kimberly, Idaho USDA Research Center
- University of Central Florida, Stormwater Academy
- Jerald S. Fifield, Ph.D.
- Applied Polymer Systems Web Site

Mixing Devices

- Ditch Mixing System- Applied Polymer Systems
- Baffle Grid System- Applied Polymer Systems
- Split Pipe System- Applied Polymer Systems
- Direct Mix-Applied Polymer Systems
- Equipment Motion- Applied Polymer Systems
- L.I.P.V.A.C.S- Ecological Pond Rescue
- PAM Wagon-Ecological Pond Rescue
- Link Manifold System- R.H. Moore & Associates
- Floc Pit- R.H. Moore & Associates
- Floc Hog- Interface H2O

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