Design and Management of CDFs

Effluent and Runoff Quality Assessment

Susan Bailey

US Army ERDC, Vicksburg, MS

Susan.E.Bailey@usace.army.mil

Topics

- Regulatory definition & requirements
- Environmental concerns
- Tiered approach
- Testing & Modeling
- Controls
- Recap


Huron Harbor CDF


Buffalo Harbor CDF

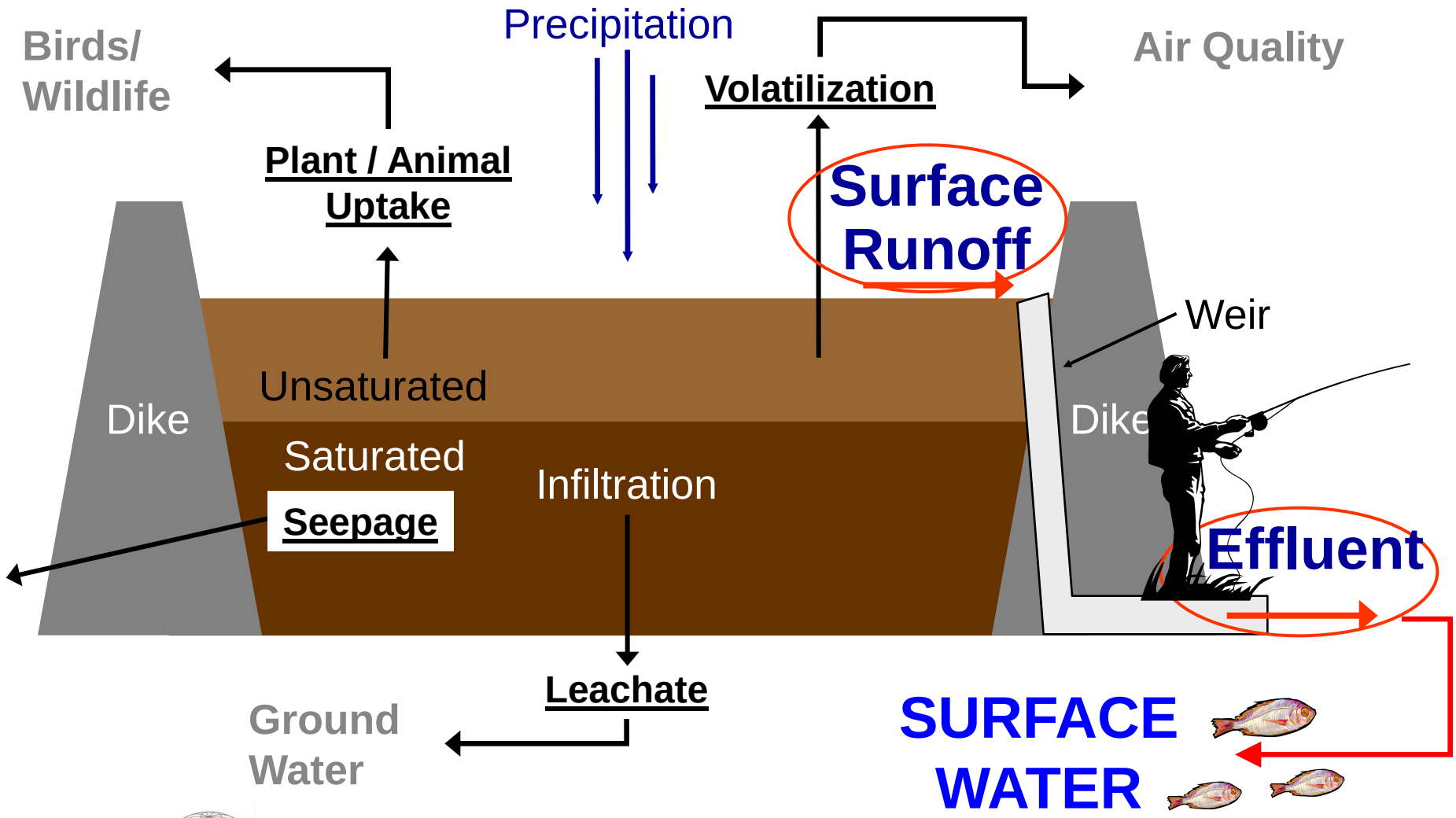
Regulatory Definition
33 CFR 323.2

"…the term 'discharge of dredged material' … includes… the runoff or overflow from a contained land or water disposal area…"

CWA Regulatory Provisions

- **Water Quality Standards**
  - Adopted per 40 CFR 131
  - Narrative or numeric criteria
  - Dissolved or total concentrations
- **Initial Mixing**
  - As per 40 CFR 230.3(m)
  - Normally expressed as a distance from point of discharge or area around the discharge

Conceptual Model - Contaminant Pathways



Characteristics Effluent vs. Runoff

	Effluent	Runoff
Occurrence / Duration	Continuous discharge during disposal & initial dewatering Weeks to months	Discrete events throughout life of facility Hours to days
Flow Rate	Dredge discharge rate for hydraulic dredges Minimal effluent flow rate if mechanically dredged	Depends on rainfall intensity, duration, CDF area and site management
Characteristics	TSS < 100 mg/L for estuarine or < a few g/L for freshwater Dissolved contaminants in equilibrium with influent slurry of 70 to 250 g/L unoxidized DM Total contaminant is a function of TSS and contaminant concentration of fines	TSS dependent on holding time, 100 mg/L to a few g/L Dissolved contaminants in equilibrium with runoff slurry of 0.5 to 15 g/L unoxidized DM or 0.05 to 3 g/L oxidized DM Total contaminant is a function of TSS and contaminant concentration of fines

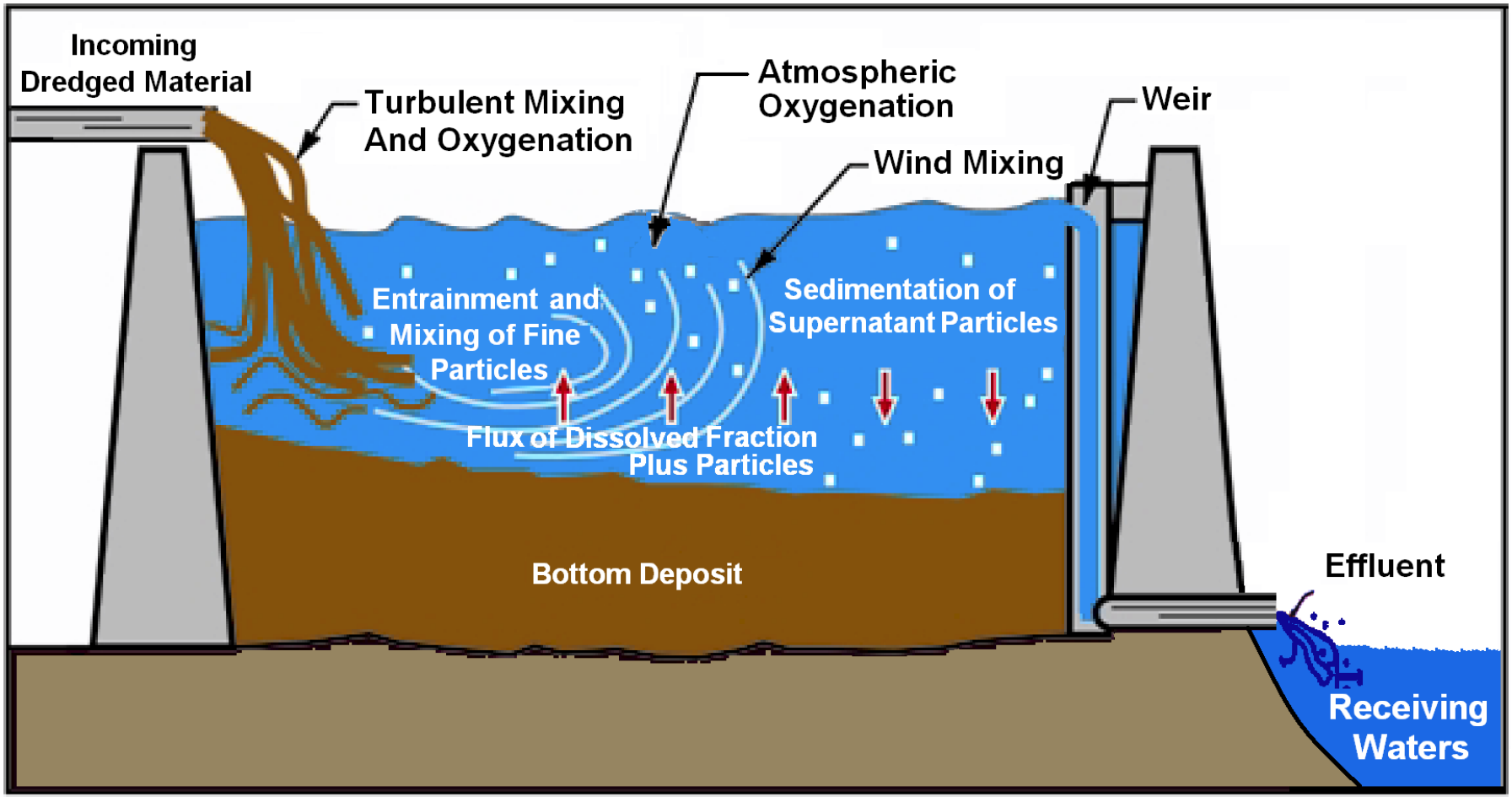
Tiered Approach

- **Tier 1 - Existing information**
- **Tier 2 - Partitioning (screening assessment)**
- **Tier 3 – Testing**

	Effluent	Runoff
Contaminant Evaluations	Column Settling Test EET chemistry	SLRP chemistry RSLS chemistry
Toxicity	EET toxicity	SLRP/RSLS toxicity

- **Tier 4 – Case specific studies**

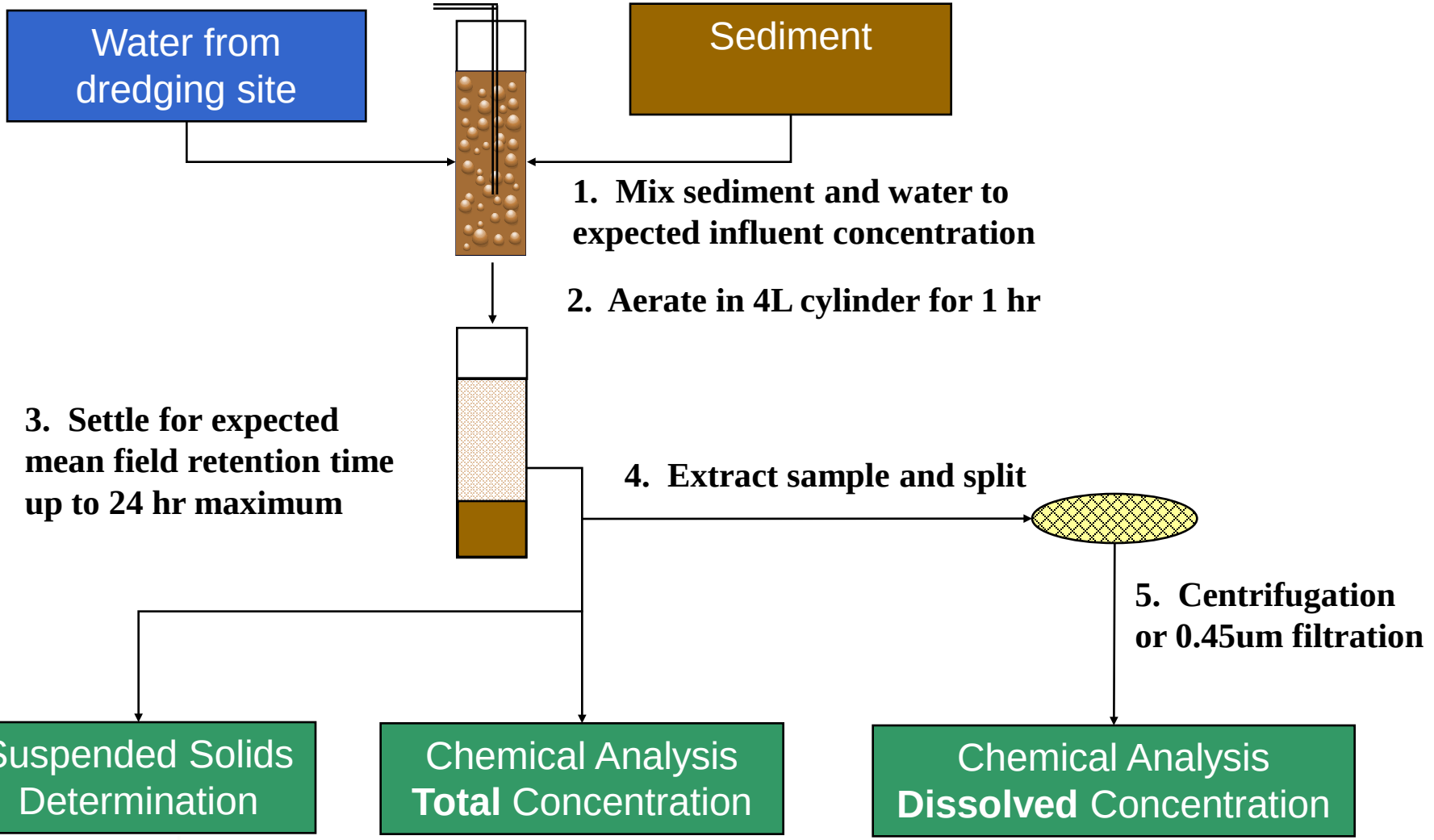
CDF Effluent Supernatant Water Interactions



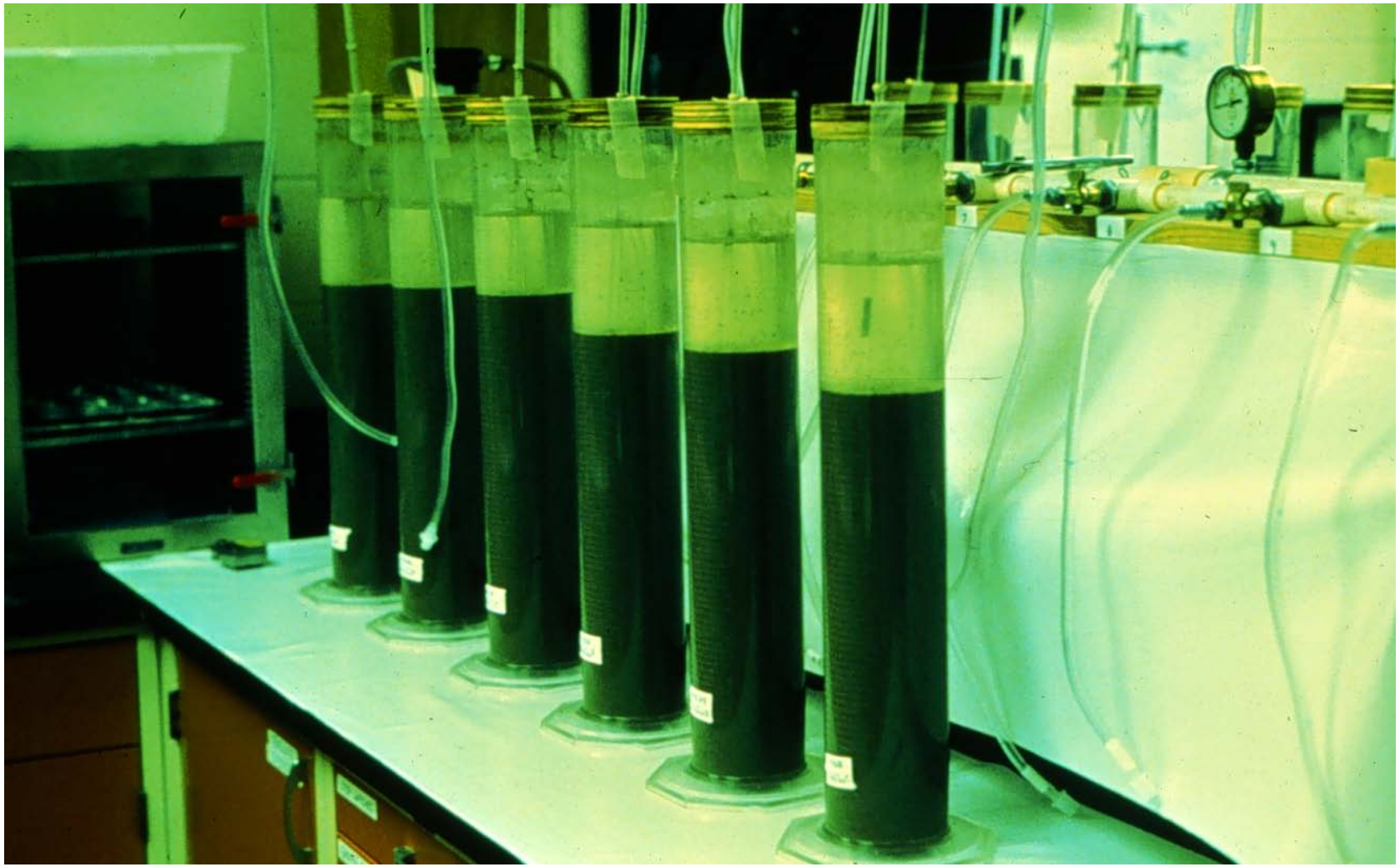
Basis of Effluent Quality Predictions

- **Partitioning**
  - Theoretical (screening spreadsheets)
- **Testing**
  - Contaminant mobilization - Modified Elutriate Sedimentation – Column Settling
  - Total = Dissolved + Particle Associated
- **Unoxidized conditions**

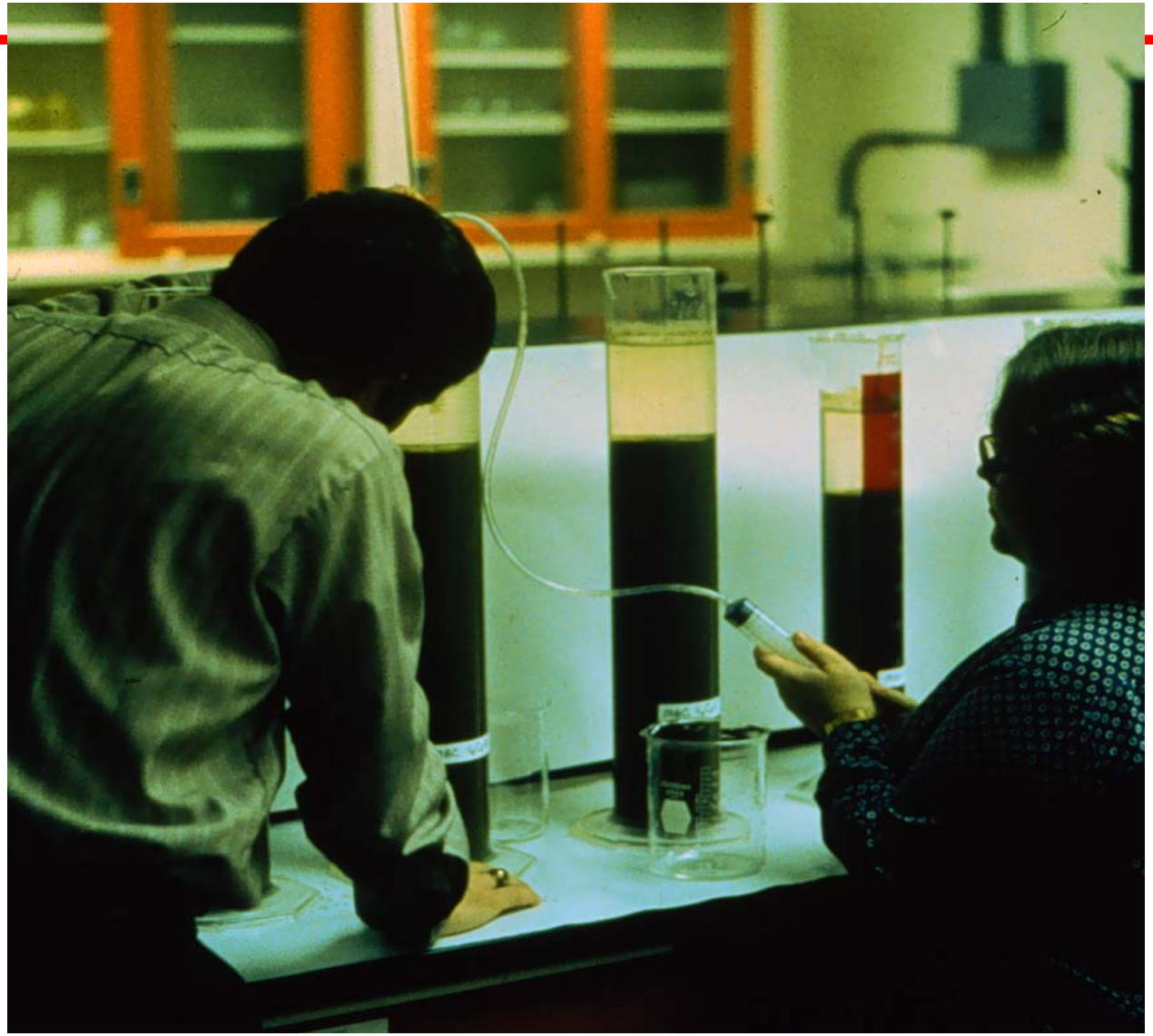
Modified Elutriate Test



Modified Elutriate Test Setup

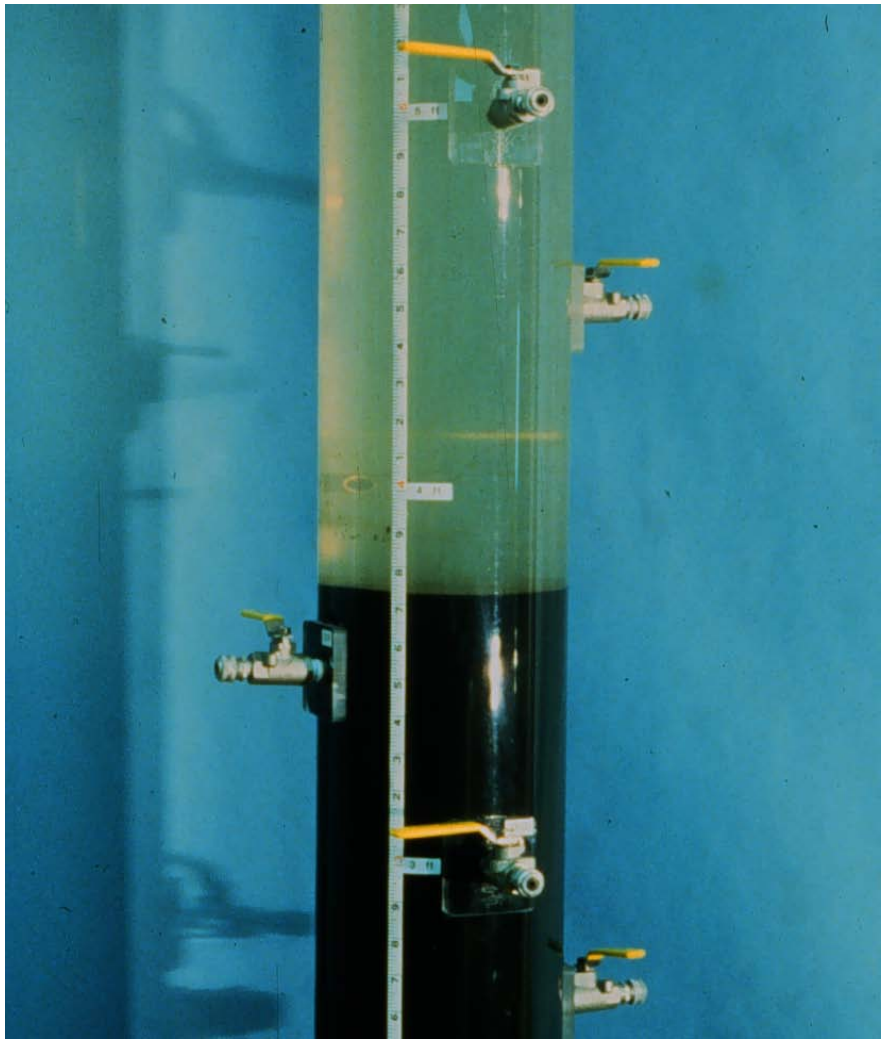


Extraction of Elutriate



Column Settling Test

- **Column**
  - 8-in diameter, > 6-ft tall
  - Ports every 6 in.
- **Fill column with slurry at expected influent solids concentration**
  - *Csl = % Fines + (3 x % Coarse)*
- **15 day test**
  - Sample supernatant TSS
  - Record interface height
- **Predict rate of settling and effluent TSS**
  - SETTLE model



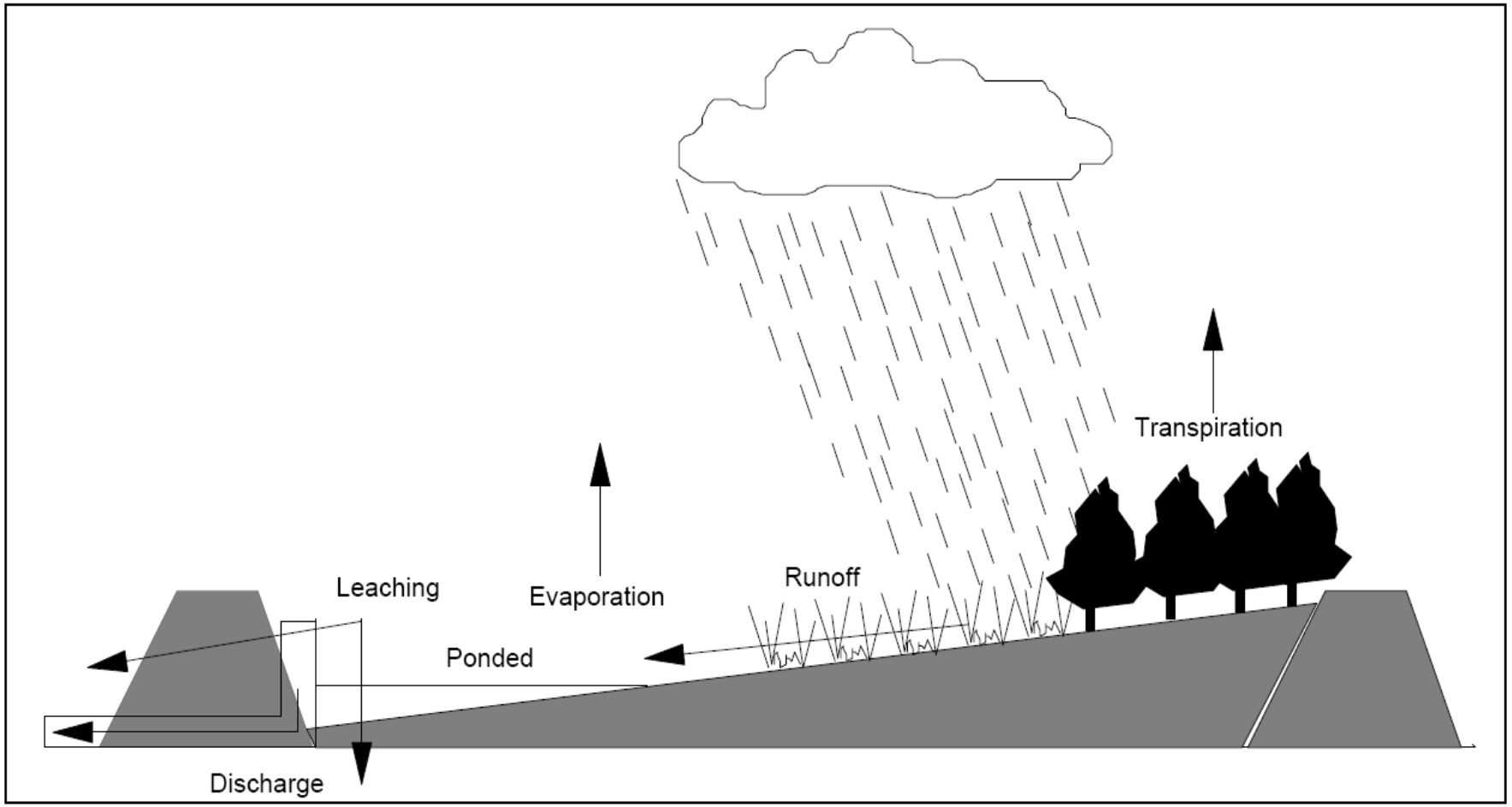
Effluent Toxicity Evaluation

- **Effluent elutriate used as test medium**
- **Procedure same as for open water**
  - Expose test organisms to dilution series of whole effluent elutriate
    - Must be sufficiently clear for organisms to be visible
  - End result is LC50 or EC50 expressed as percentage of original effluent elutriate concentration
  - Detailed procedures in ITM
- **Compare with effluent concentration at the boundary of the allowable mixing zone**
  - Must not exceed 0.01 of LC50 or EC50

ADDAMS Effluent Quality Modules

- **SETTLE**
  - CDF sizing for storage and effluent TSS
- **EFQUAL**
  - Reduction of modified elutriate data
    - Determine COC
  - Water quality standards compliance
  - Dilution requirements
- **LAT-E**
  - Analysis of water column bioassay test to determine toxicity (LC50) of CDF effluent
- **EFFLUENT**
  - Windows version of the above two modules

CDF Surface Runoff Process



Basis of Runoff Water Quality Predictions

- **Partitioning**
  - **Theoretical (screening spreadsheets)**
- **Testing**
  - **SLRP/RSLS**
- **Total and Dissolved**
- **Oxidized and Unoxidized Conditions**
  - **Unoxidized analysis may not be necessary**

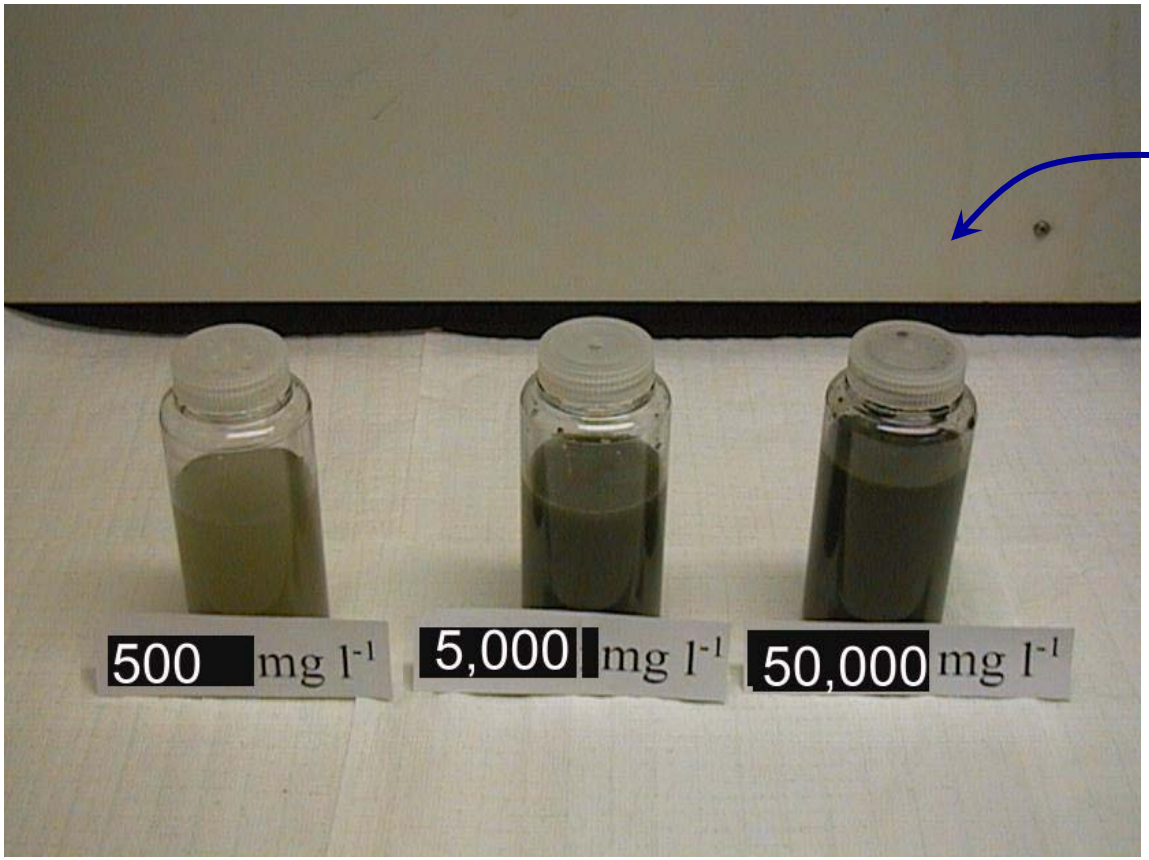
Simplified Laboratory Runoff Procedure (SLRP) Wet Sediment

- 3 gal sediment
- Common laboratory equipment
- Dilute to representative TSS
- Agitate for one hour
- Analyze contaminant concentrations
  - Filtered for soluble
  - Unfiltered for total

Field SS Measurements

Sediment (mg/L)	SS, Wet	SS, Dry
Indiana	6600	56
Black Rock	10326	167
Everett	6900	1000
New Bedford	7730	268
Oakland Inner	4447	1686
Oakland Outer	9140	970
Pinole Shoal	1500	618
West Richmond	3290	2340
Santa Fe	6240	2130

SLRP SS Concentrations



SLRP-Wet Concentrations

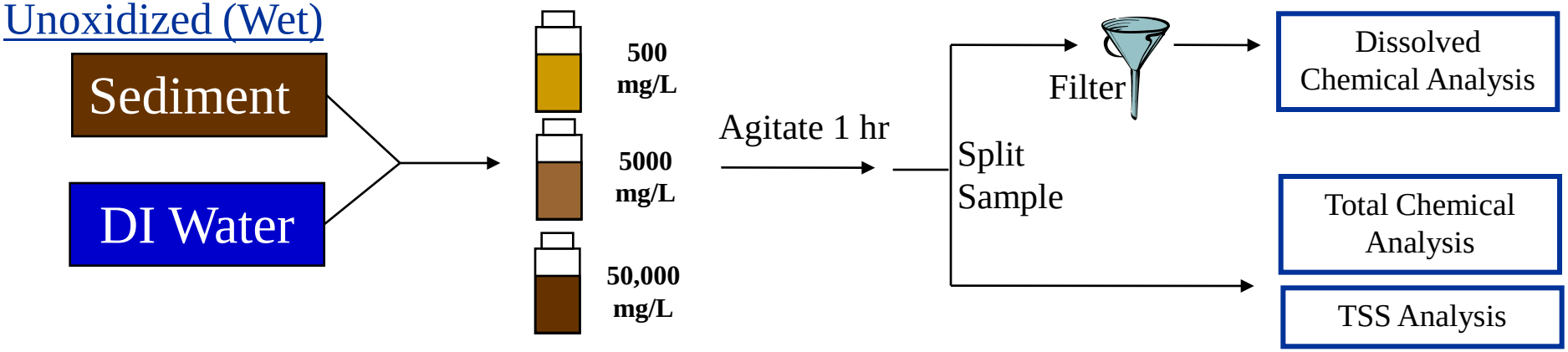
SLRP-Dry Concentrations - 50, 500, 5000 mg/L

SLRP - Dry Sediment

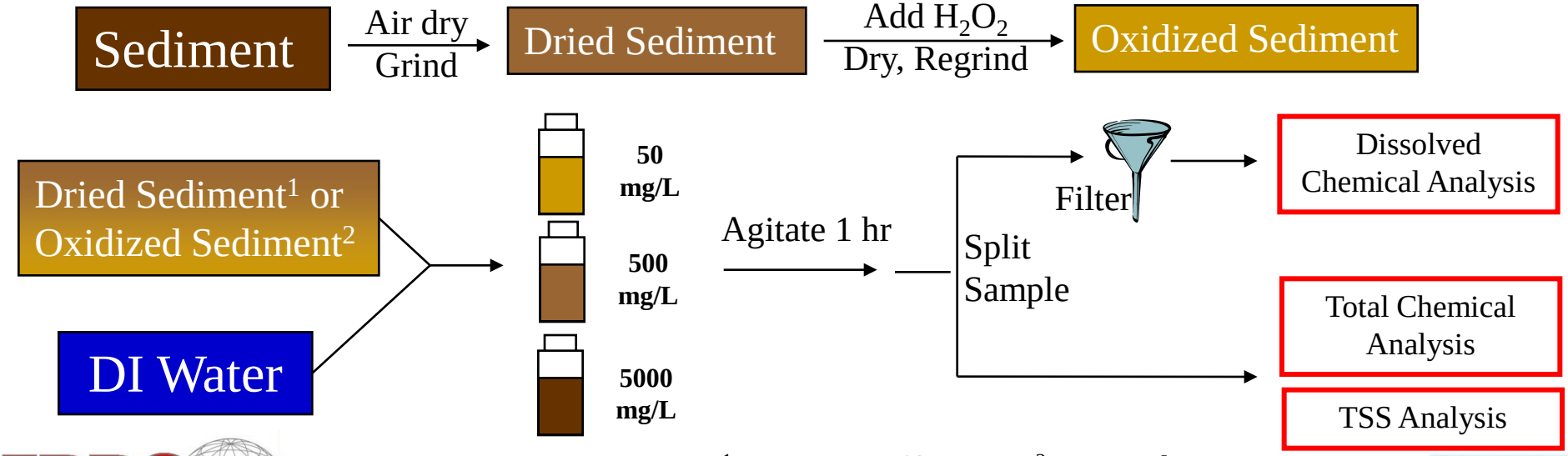
- Air dry to < 5% moisture and grind
- Oxidize with H_2O_2, dry and regrind
- Re-slurry at TSS 50, 500, 5,000 mg/l, agitate and extract
- Analyze for total and dissolved contaminants

SLRP Procedures

Unoxidized (Wet)

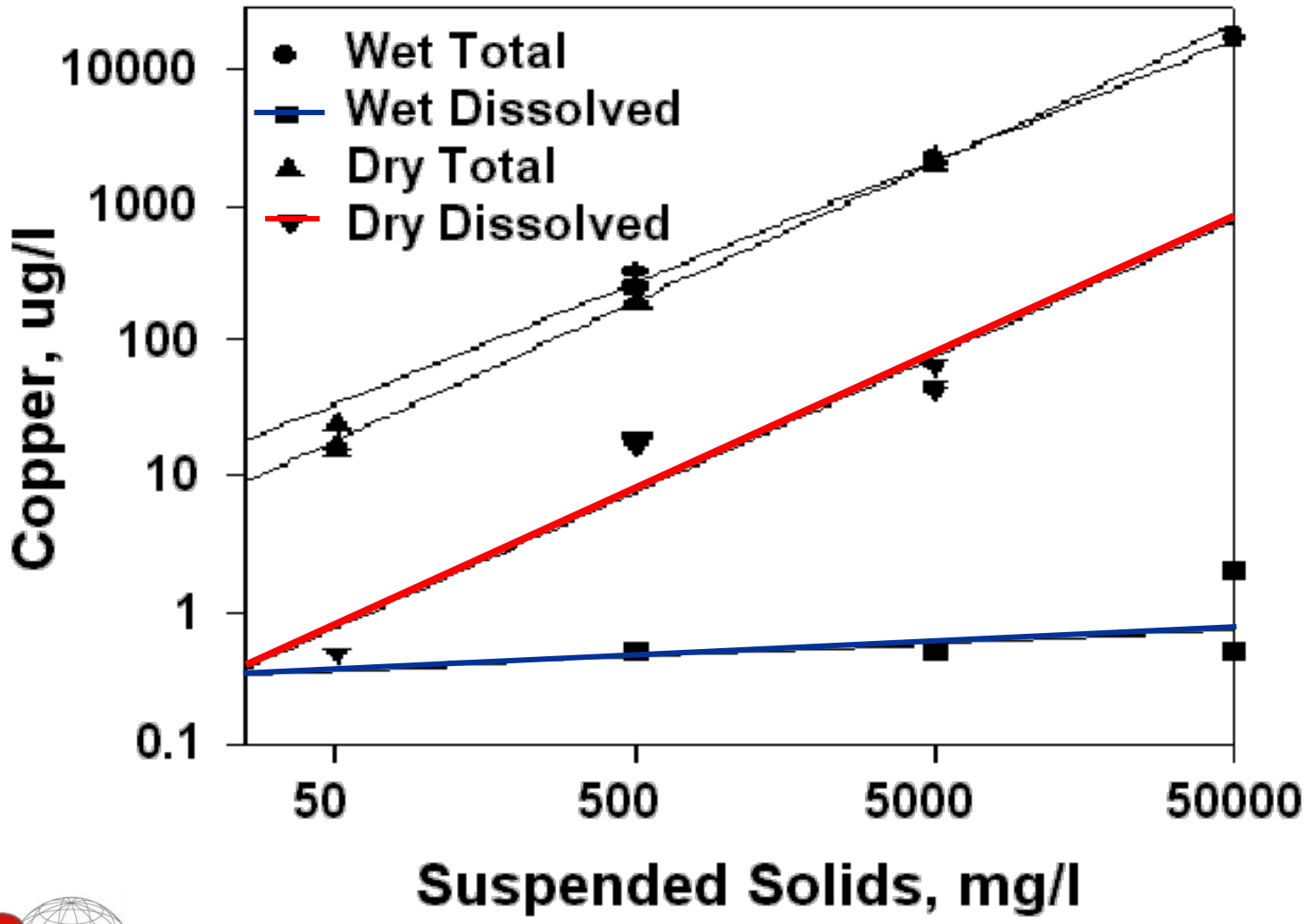


Oxidized (Dry)



[1]For Nutrients/Organics; [2]For Metals

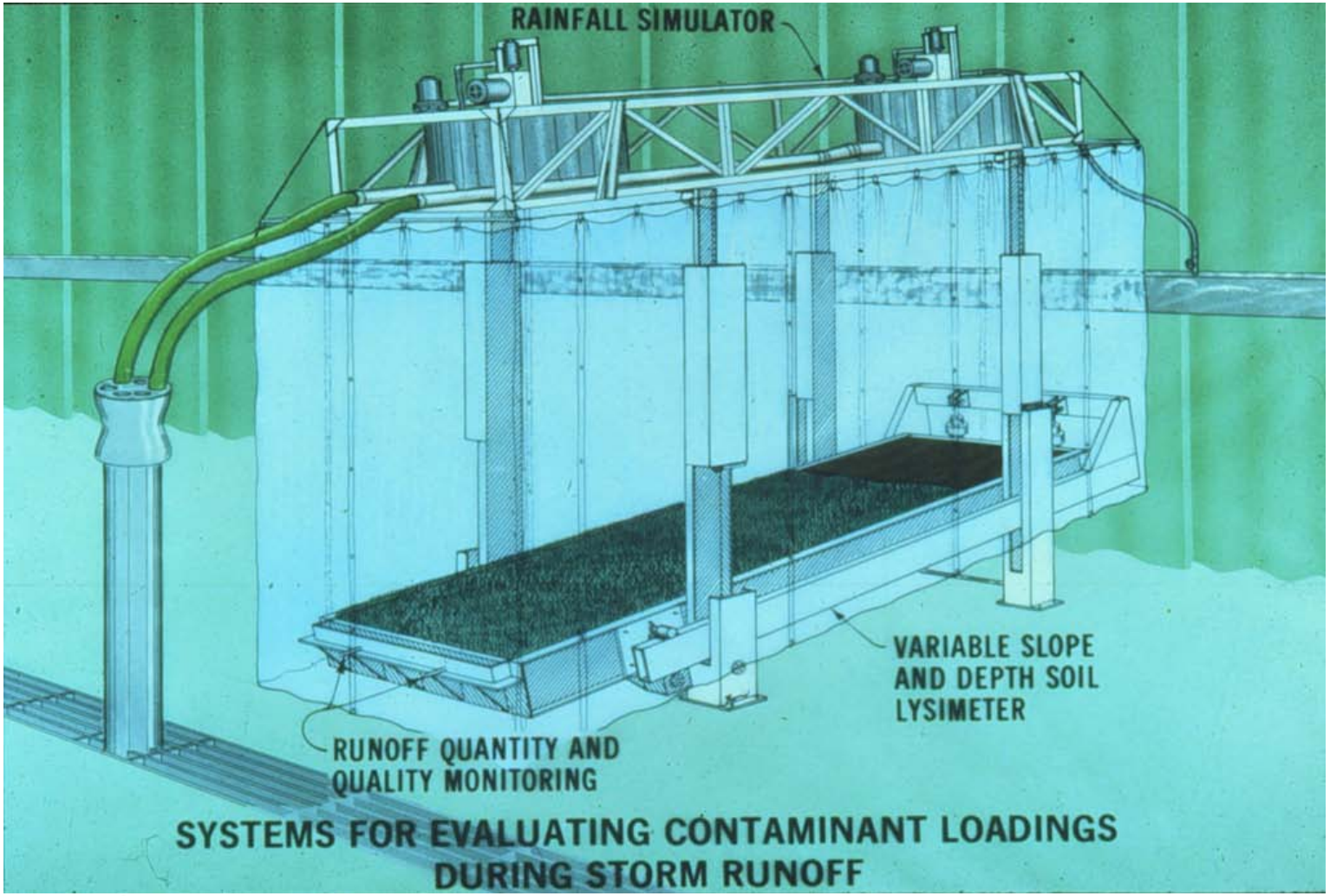
SLRP Predicted Copper



Rainfall Simulator/Lysimeter System (RSLS)

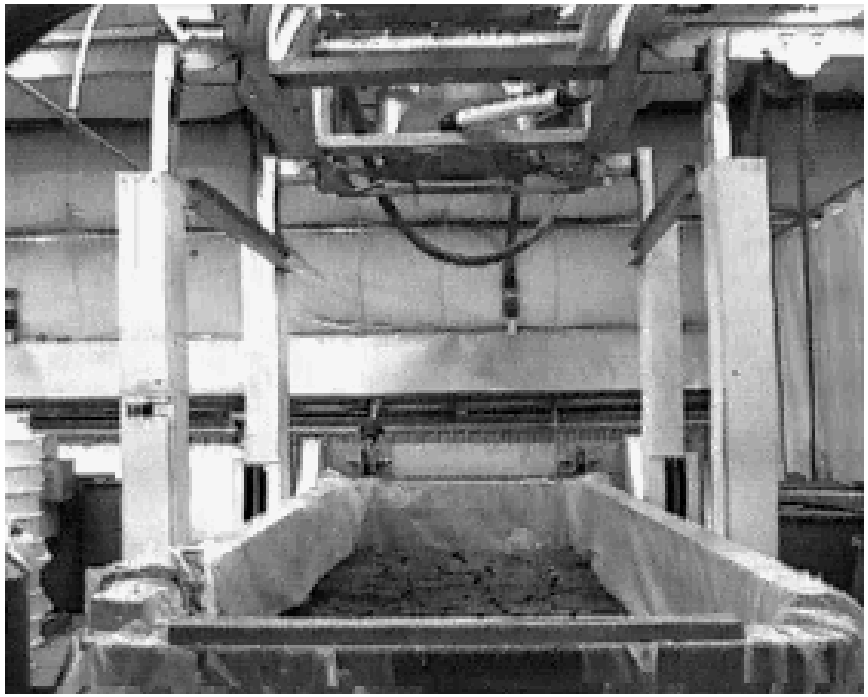
- 600 gal sediment from dredging site
- Specialized equipment
- Conduct test on wet sediment (unoxidized) first
- Allow sediment to dry 6 months, then repeat test on oxidized sediment

RSLS Test Equipment



RSLS Test Specifics

- **Rainfall**
  - 5.08 cm/hr (2 in/hr)
  - 30 min event
  - 3 events on consecutive days
- **Sample**
  - Runoff rate - every minute
  - pH, TSS, EC
    - Every minute up to 15 min, then every 5 min
  - Chemical analysis
    - composite of 5, 15 and 25 min after runoff begins
    - dissolved and total
- **Can modify test to match site-specific conditions**



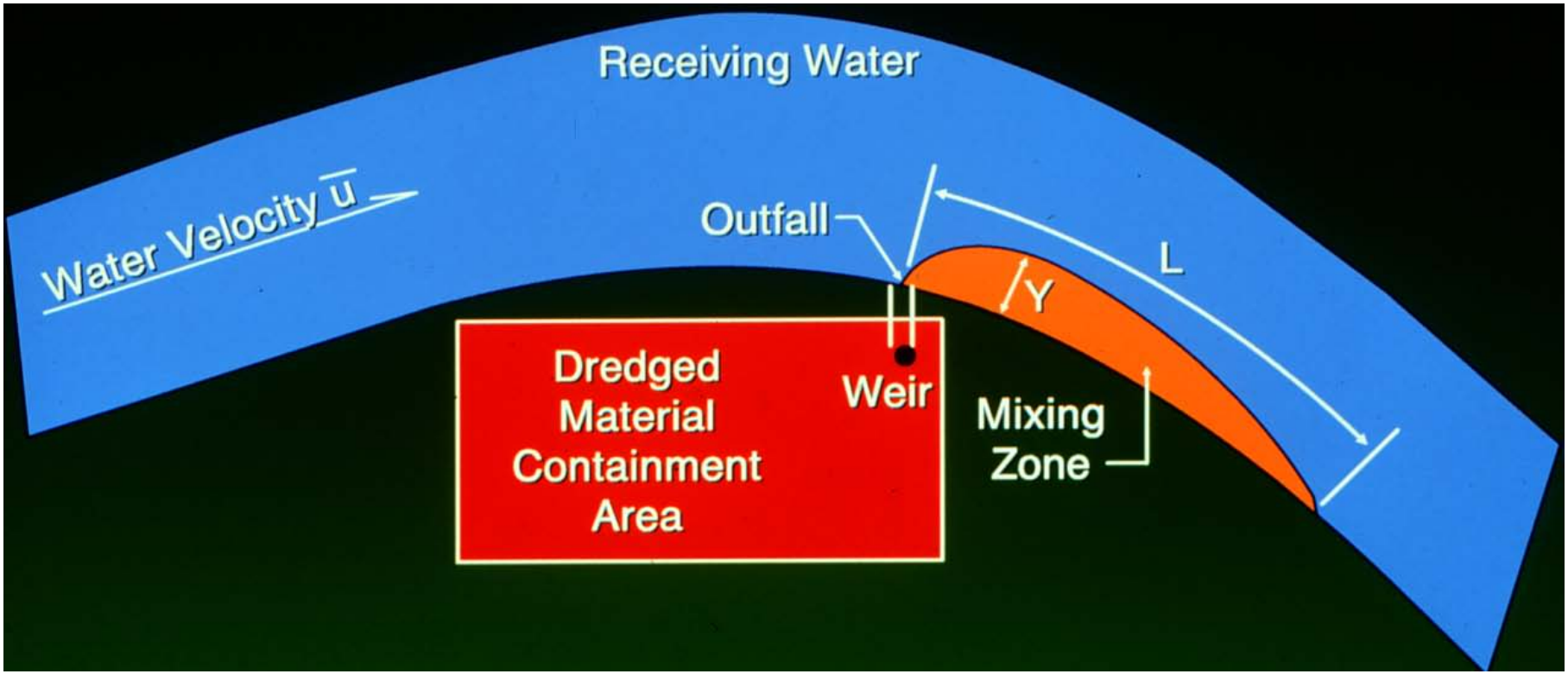
Runoff Toxicity Evaluation

- **Simulated runoff from SLRP or RSLS used as medium**
  - Whole water (not filtered)
  - Sufficiently clear for organisms to be visible
- **Procedure same as for open water**
  - Expose organisms to dilution series of test medium
  - End result is LC50 or EC50, expressed as percentage of original simulated runoff concentration
  - Detailed procedures in ITM
- **Compare with runoff concentration at boundary of allowable mixing zone**
  - Must not exceed 0.01 of LC50/EC50 (or NOEL/LOEL)

ADDAMS Runoff Quality Programs

- **RUNQUAL**
  - Compares predicted runoff WQ with standards
  - Determines COC
  - Dilution requirements
- **LAT-R**
  - Analysis of water column bioassay test to determine toxicity (LC50) of CDF runoff
- **RUNOFF**
  - Windows version of the above two modules

Schematic of a Mixing Zone for a Single Effluent Source



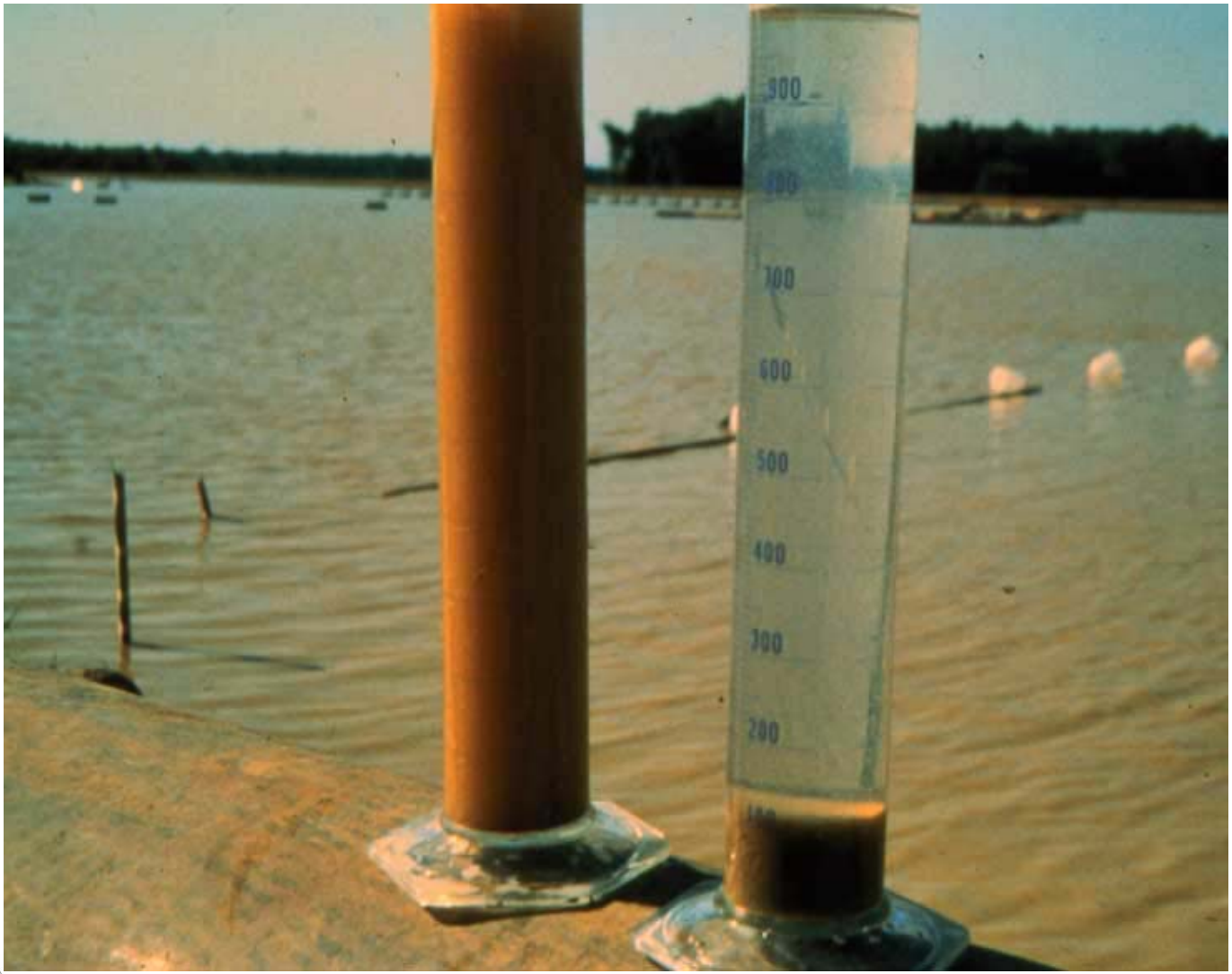
CDF Effluent Mixing Models

Model/Technique	Hydrodynamics	Conditions
Dilution Volume	Steady Uniform	General
MacIntyre	Steady Uniform	Riverine
CDFATE (CORMIX)	Steady Uniform	
TABS	Unsteady Nonuniform	Tidally influenced Rivers & Estuaries

Contaminant Controls

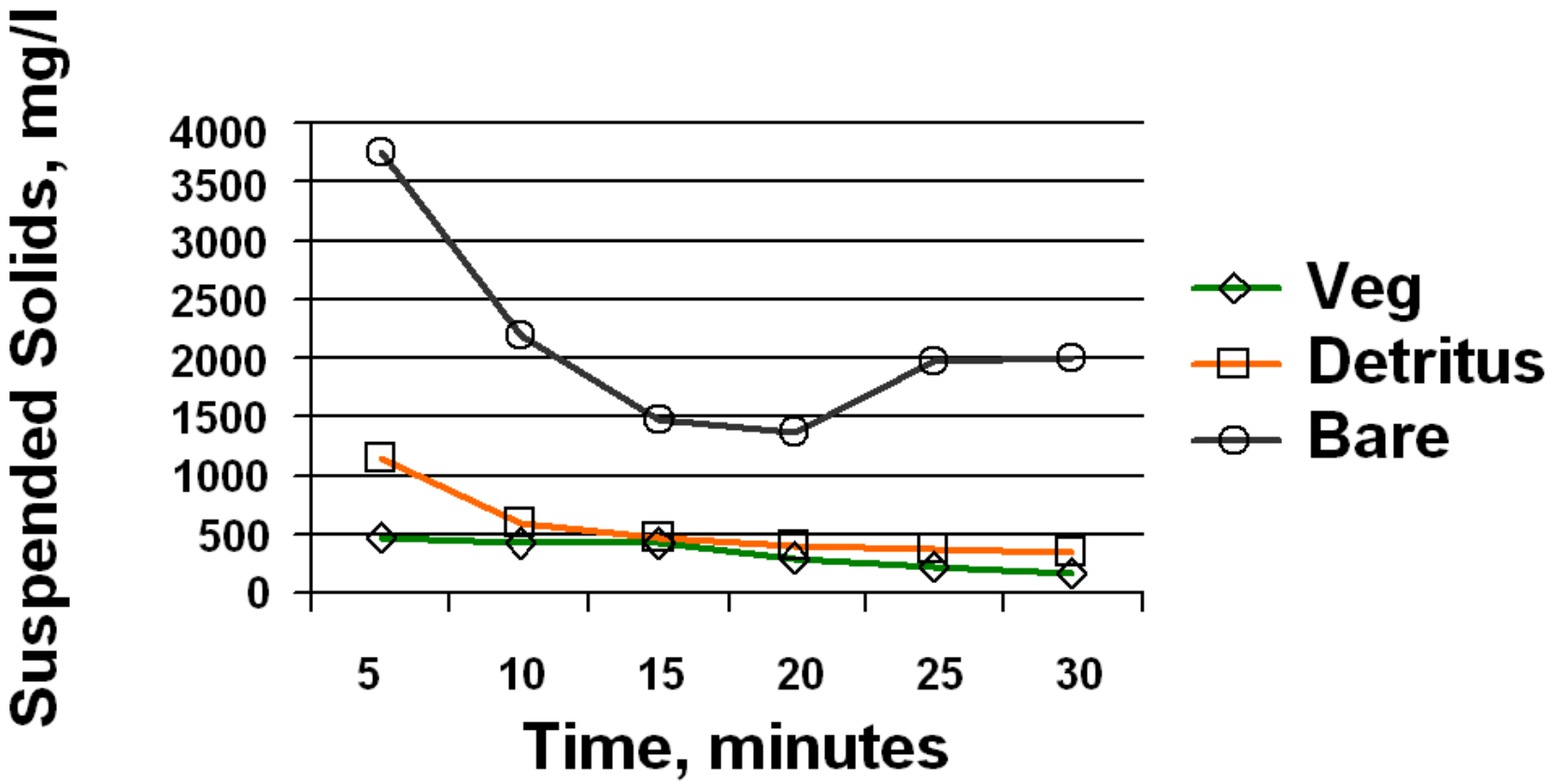
- **TSS & Particulate Associated Contaminants**
  - Operational modifications – retention time
  - Filtration
  - Chemical flocculants
  - Engineered controls – vegetation, capping
- **Dissolved**
  - Treatment
    - Carbon adsorption
    - Ion exchange
    - Chemical or UV oxidation
    - Biological

Polymer Addition



Filter Cell

Runoff SS Controls



Summary

- **EFFLUENT**
- **Tier II Screening**
- **Column settling**
- **Modified elutriate**
  - Accurate
  - Relatively inexpensive
  - Generally conservative
- **Controls**
  - Operational
  - Treatment

- **RUNOFF**
- **Tier II Screening**
- **RSLS**
  - Time and material intensive
- **SLRP**
  - Rapid
  - Conservative
- **Controls**
  - Operational
  - Treatment
  - Engineered