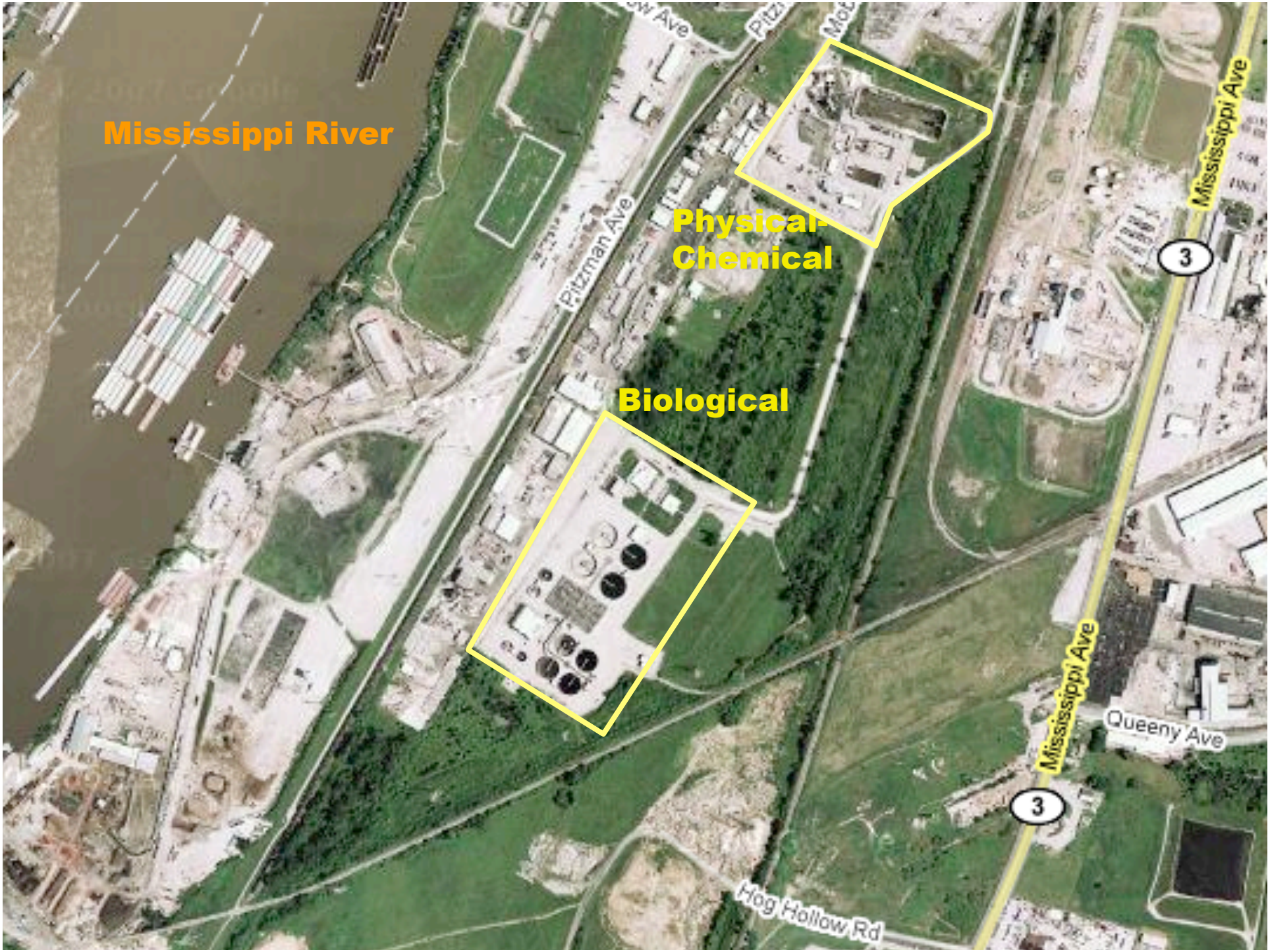
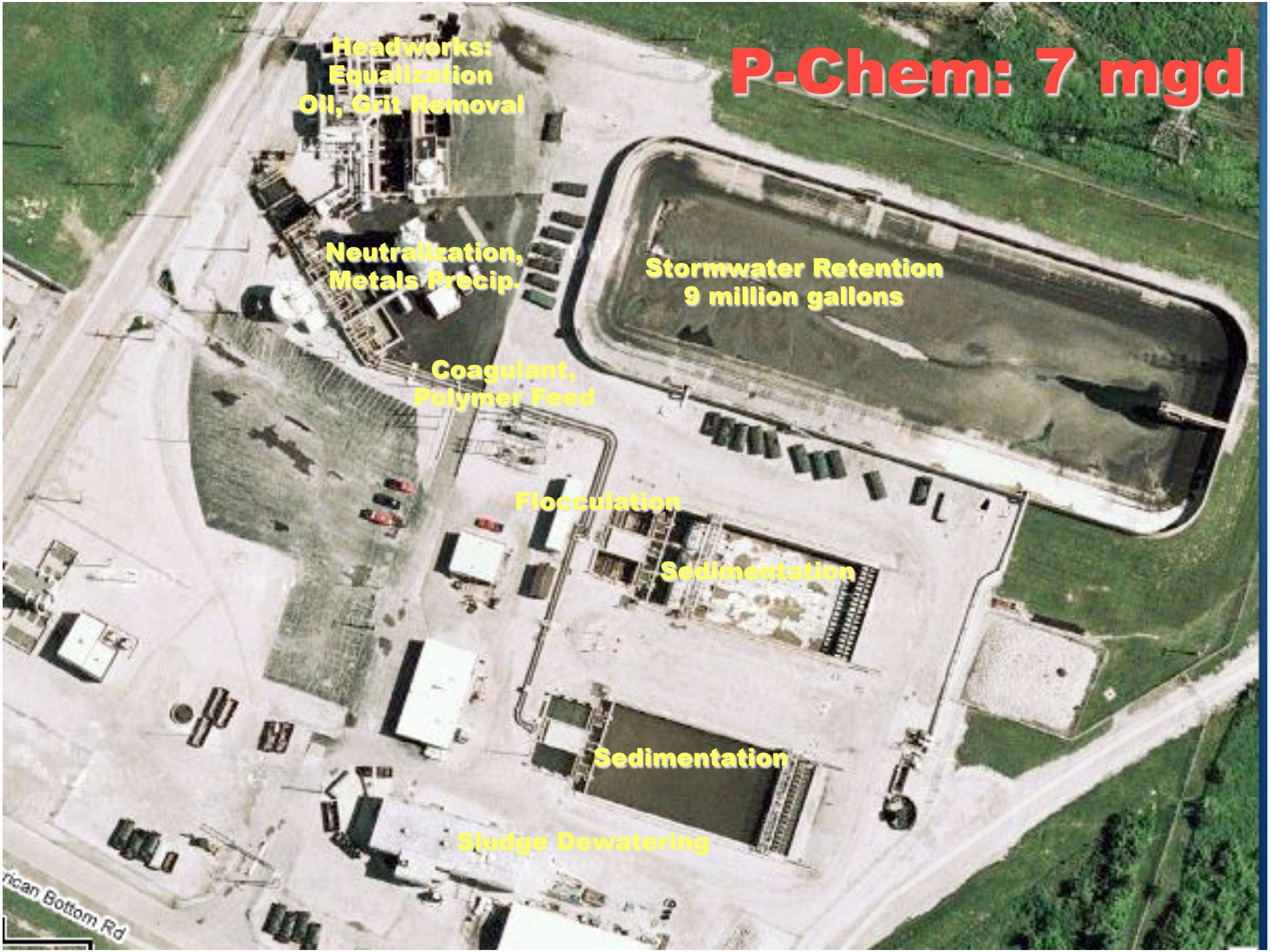

Industrial Waste Pretreatment
Equalization, Neutralization, Metals Removal
A Case Study:
American Bottoms Wastewater Treatment Plant
1 American Bottom Road, Sauget, Illinois
Dr. John T. O'Connor, PE
H2O'C


290C
Missouri
Illinois
St. Louis
Kosciusko
7th Blvd
American Bottoms
Wastewater Treatment
Plant
Sauget
Mississippi Ave
Falling Springs Rd
Sauget
3
B

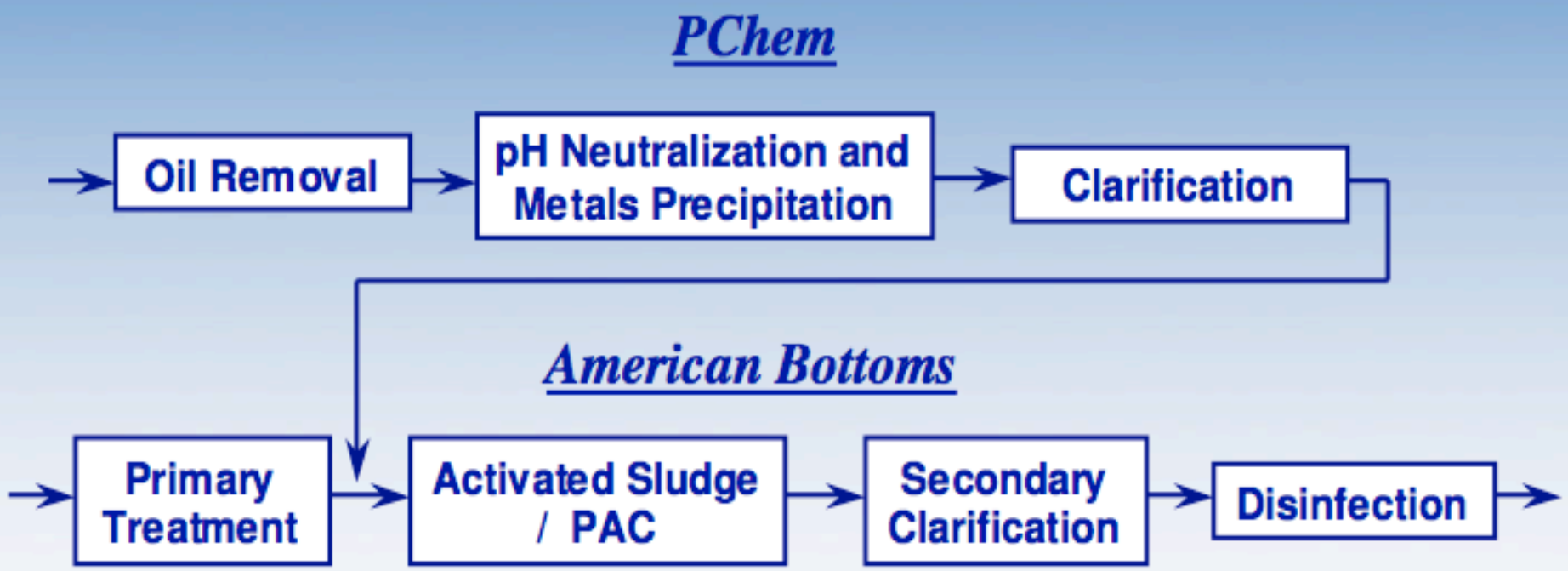

Mississippi River
Physical-
Chemical
Biological
Pitzman Ave
Mississippi Ave
Mississippi Ave
Queeny Ave
Hog Hollow Rd
3
3


26 MGD
Biological Treatment:
•Primary Sedimentation
•Activated Sludge with PAC
•Nitrification
•Secondary Sedimentation
•Disinfection


7 MGD
Physical-Chemical Plant
•Oil, Grit Removal
•Equalization
•Neutralization, Metals Removal
•Clarification
•Sludge Dewatering & Disposal
Mobile St
American Bottom Rd


P-Chem: 7 mgd
Headworks:
Equalization
Oil, Grit Removal
Neutralization,
Metals Precip.
Stormwater Retention
9 million gallons
Coagulant,
Polymer Feed
Flocculation
Sedimentation
Sedimentation
Sludge Dewatering
rican Bottom Rd

American Bottoms Wastewater Treatment



Waste Contributors

Solutia (formerly Monsanto)

Sulfuric, Hydrochloric, Phosphoric, Formic Acids

Ammonia, Aniline, Benzene, Xylene, Ethylene Glycol

Methylethyl ketone, Methylisobutyl ketone,

Monochlorobenzene, Orthodichlorobenzene,

Orthonitrophenol, Paranitrophenol

Waste Contributors

Cerro Copper

#2 Fuel Oil

Gasoline

Kerosene

Trichloroethylene

Ethyl Corporation

Gear Crankcase Oil

Transmission Fluid

Benzene

Isobutylene

$H_2O'C$

Waste Contributors

Big River Zinc

Arsenic, Cadmium, Calcium, Manganese, Sodium

Zinc & Copper Sulfate, Sulfuric Acid

#2 Diesel Fuel, Gasoline, PCB

Potassium Permanganate, Soda Ash,

Sodium Hydrosulfide, Strontium Carbonate

Physical Properties

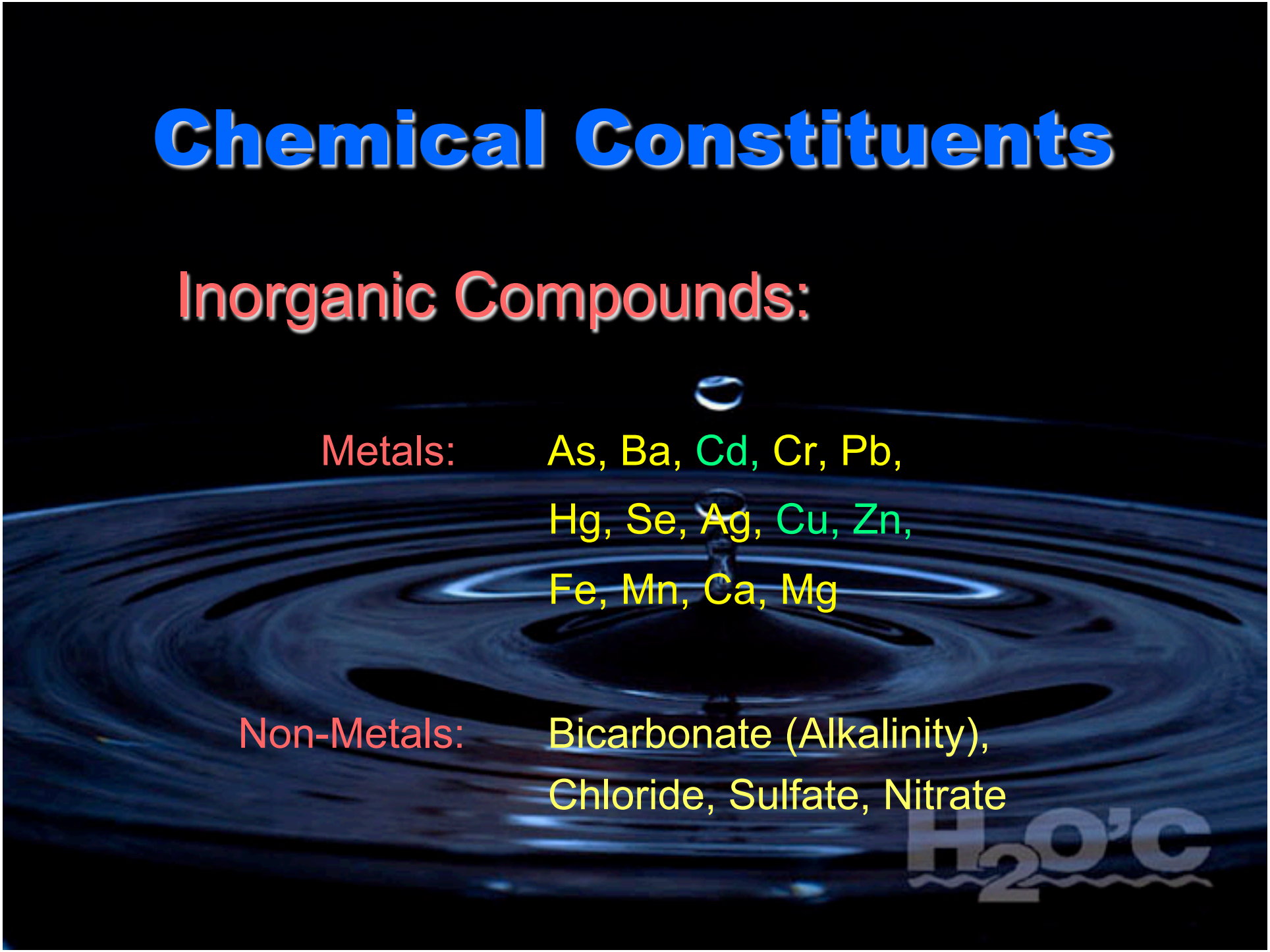
Temperature	Density, Reaction Rates
Floatables	Grease: Oils, Fats, Wax
Turbidity	Light Scattering Particles
Solids	Inorganic (sand), Organic (fiber)
Odor	Sulfides, Ammonia, Volatile Organics
Color	True (dyes), Apparent (precipitates)

Chemical Constituents

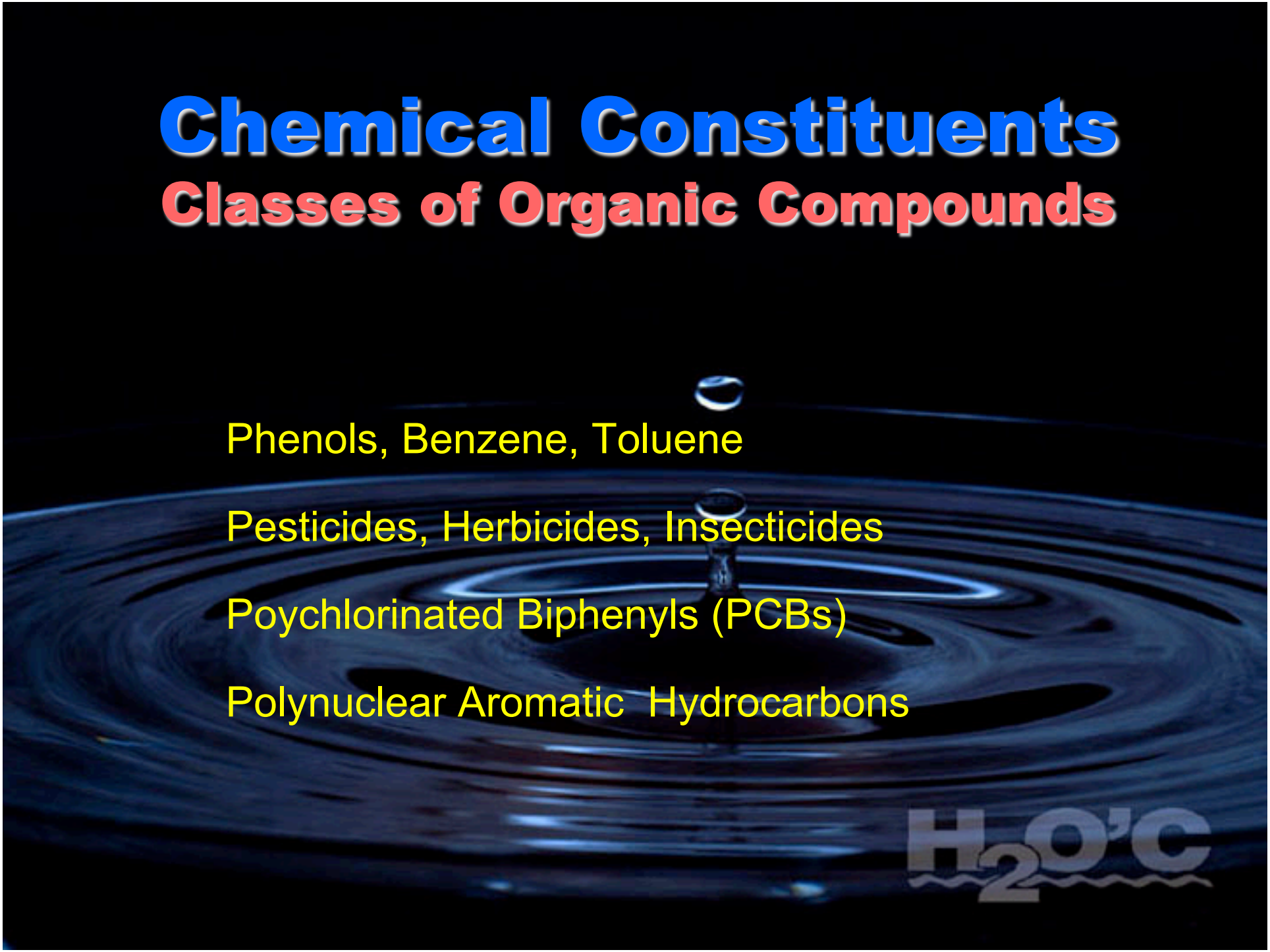
Inorganic Compounds:

Metals: As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Cu, Zn, Fe, Mn, Ca, Mg

Non-Metals: Bicarbonate (Alkalinity), Chloride, Sulfate, Nitrate



Chemical Constituents
Classes of Organic Compounds



Phenols, Benzene, Toluene

Pesticides, Herbicides, Insecticides

Poychlorinated Biphenyls (PCBs)

Polynuclear Aromatic Hydrocarbons

Municipal Wastewater

Solids:

Dissolved	500 mg/l
Suspended	200 mg/l

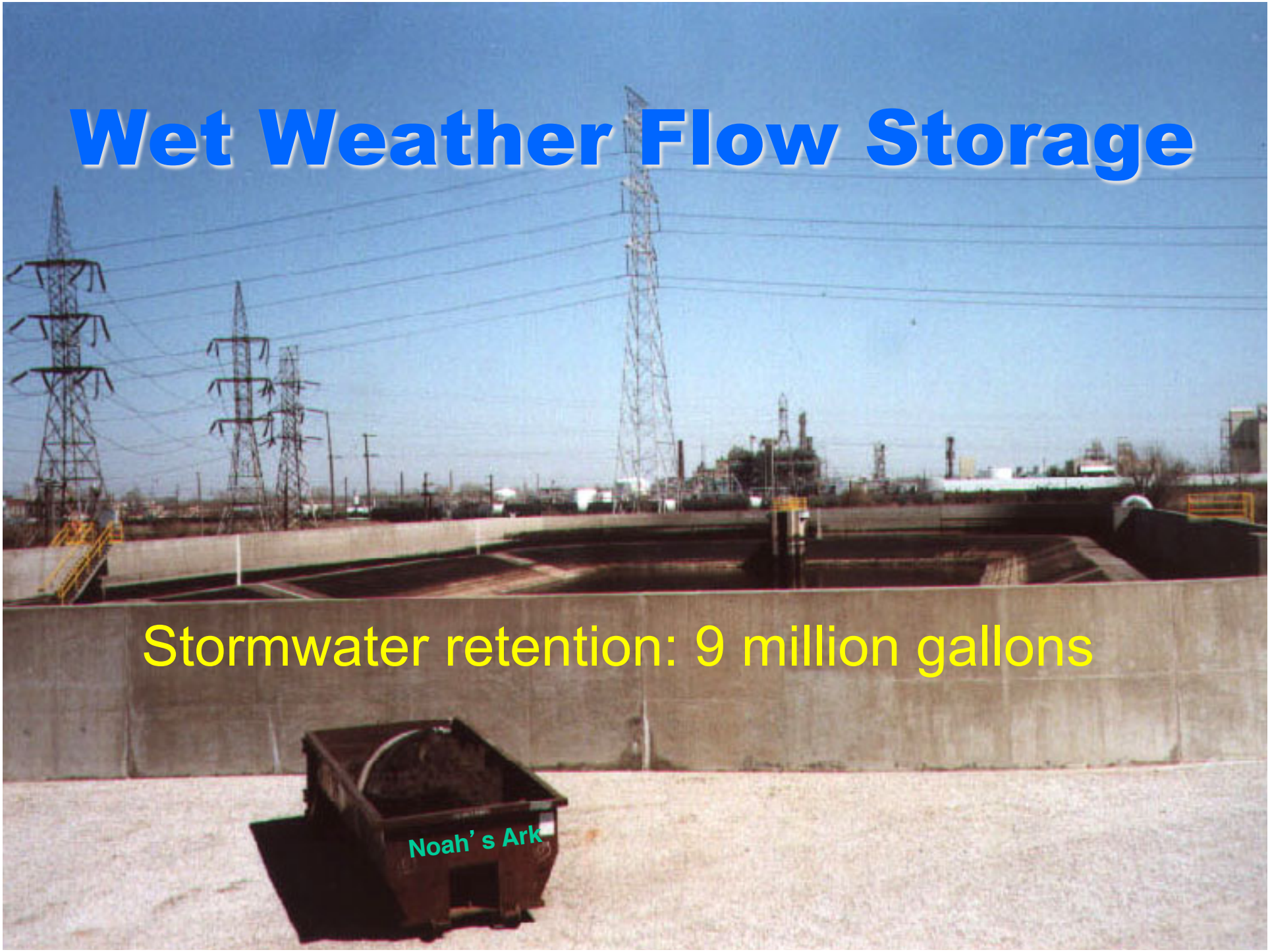
Organic Matter:

BOD 5d, 20 °C	200 mg O/l
COD	500 mg O/l
TOC	160 mg C/l

Toxic to Biological Waste Treatment

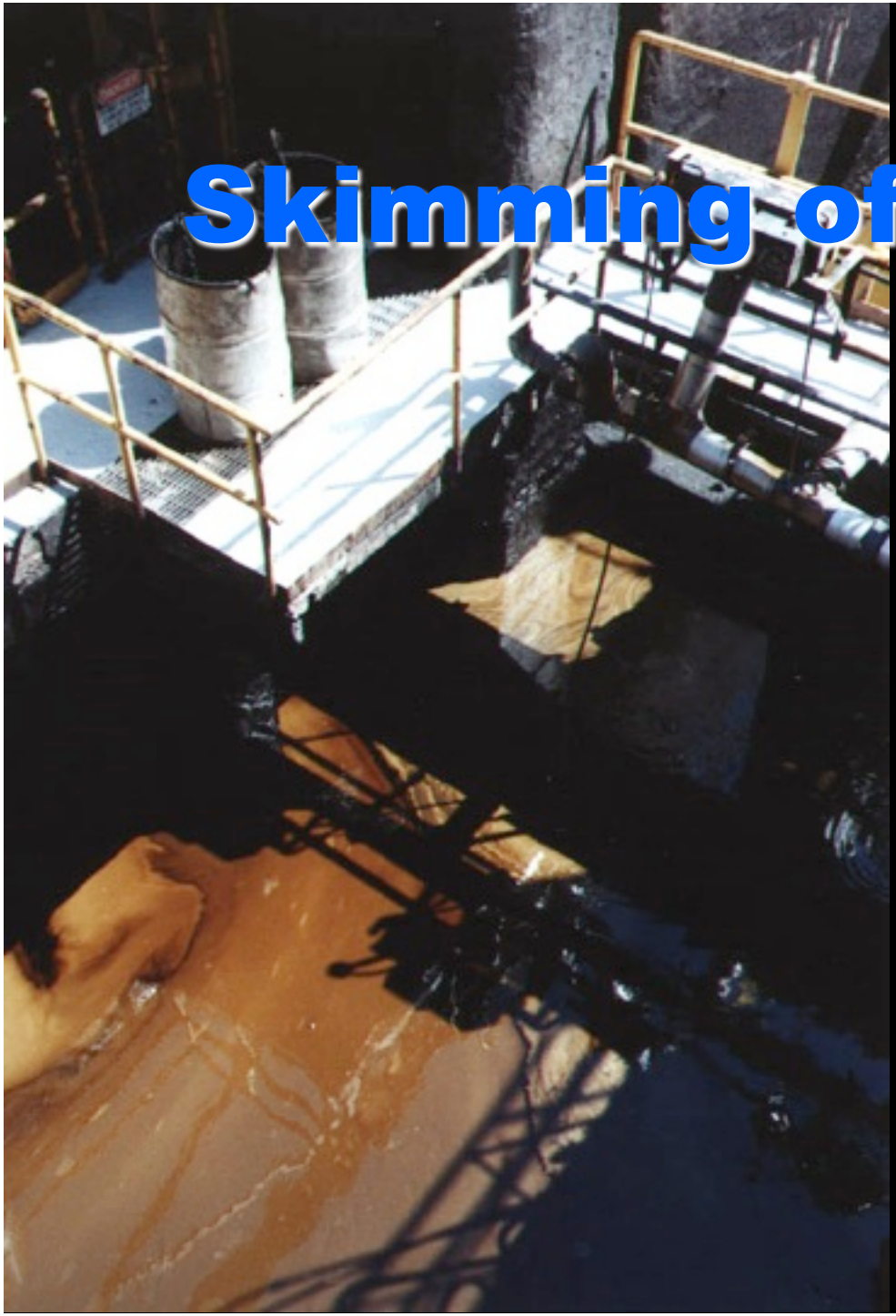
BOD	Carbonaceous	Nitrogenous
Copper	1.0	0.005
Nickel	1.0	0.25
Zinc	0.8	0.08
Cyanide	0.1	0.34
Arsenic	0.1	-
Phenols	200	4.0

Wet Weather Flow Storage



Industrial Waste Solids Removal

- Bar Racks 2” - Steel Bars
- Screens 0.5” SS Wire Mesh
- Comminutors 0.4” Slots



Skimming of Floatables

Greases:

- Fats
- Oils
- Wax

Influent Equalization

- Blending of Different Sources
- Flow Equalization
  - Daily, Seasonal Variations
  - Infiltration, Rainfall
- Waste Concentrations
  - Production Wastes vs. Cooling Waters
- Neutralization
  - Acids, Bases

Aerated Grit Chamber

Grit Settled for 60 minutes

Fine Sand > 0.2 mm,

Dense Organic Debris:

S.G. 1.3 to 2.7

Organic Matter Suspended at velocity > 1 foot / sec

Grit Collection

- Inclined Continuous Screw
- 1-4 cubic feet per million gallons

Acid Neutralization Process

Lime Storage (CaO)

Slaked Lime $Ca(OH)_2$

Mixing Basin

Lime Slurry Fed in Three Stages

Lime dissolution yields hydroxide, carbonate ions;

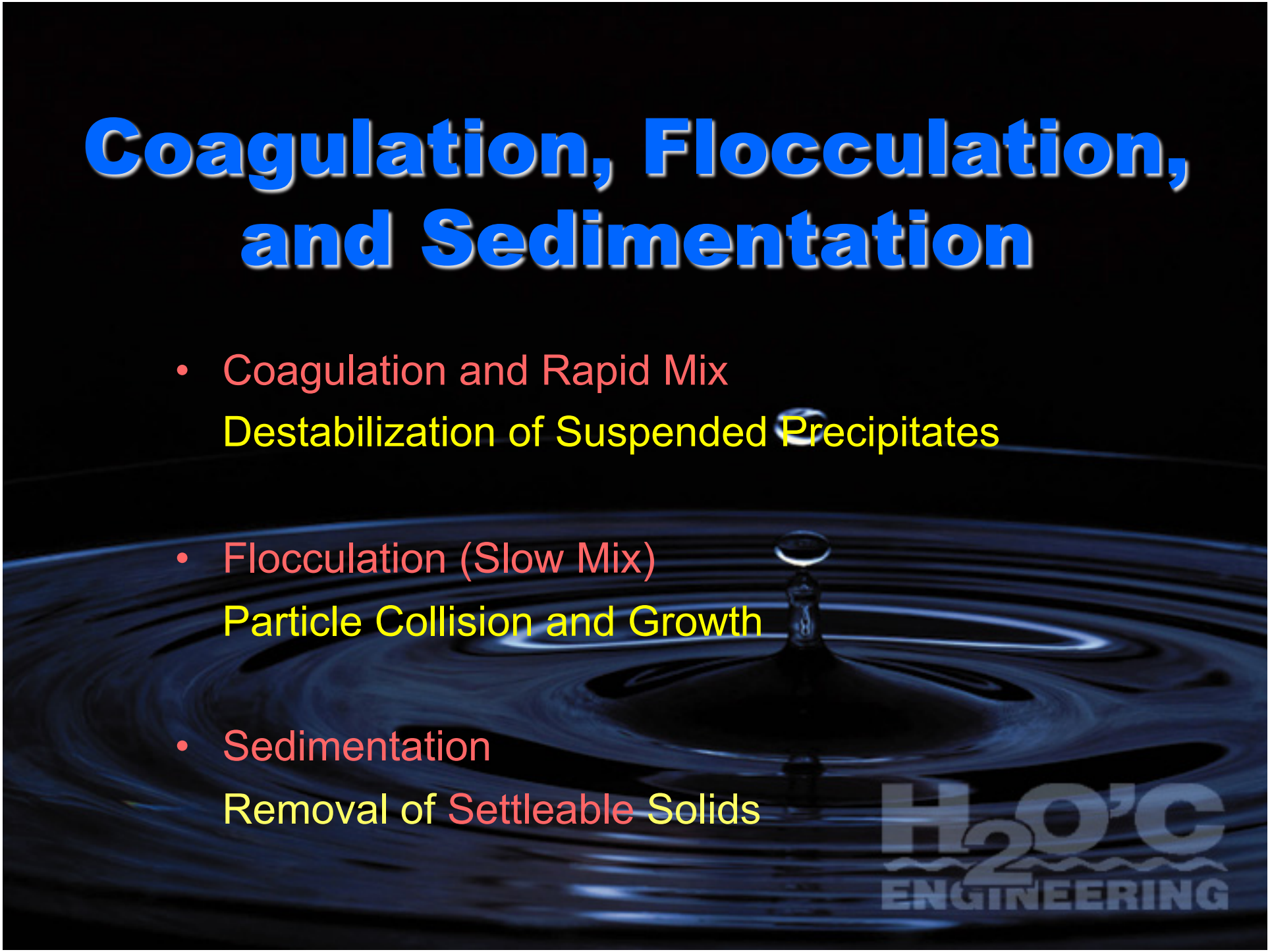
precipitates metal hydroxides,carbonates.

Neutralization Basin

Lime feed adjusted to maintain pH 8.3 in plant effluent

Coagulation, Flocculation, and Sedimentation

- Coagulation and Rapid Mix
  Destabilization of Suspended Precipitates
- Flocculation (Slow Mix)
  Particle Collision and Growth
- Sedimentation
  Removal of Settleable Solids



Solids Removal Process

Coagulation

Rapid Mix

Flocculation

Settling

Flumes

Flow diversion to two parallel treatment trains

Anionic polymer coagulant addition

Rapid mixing in flumes

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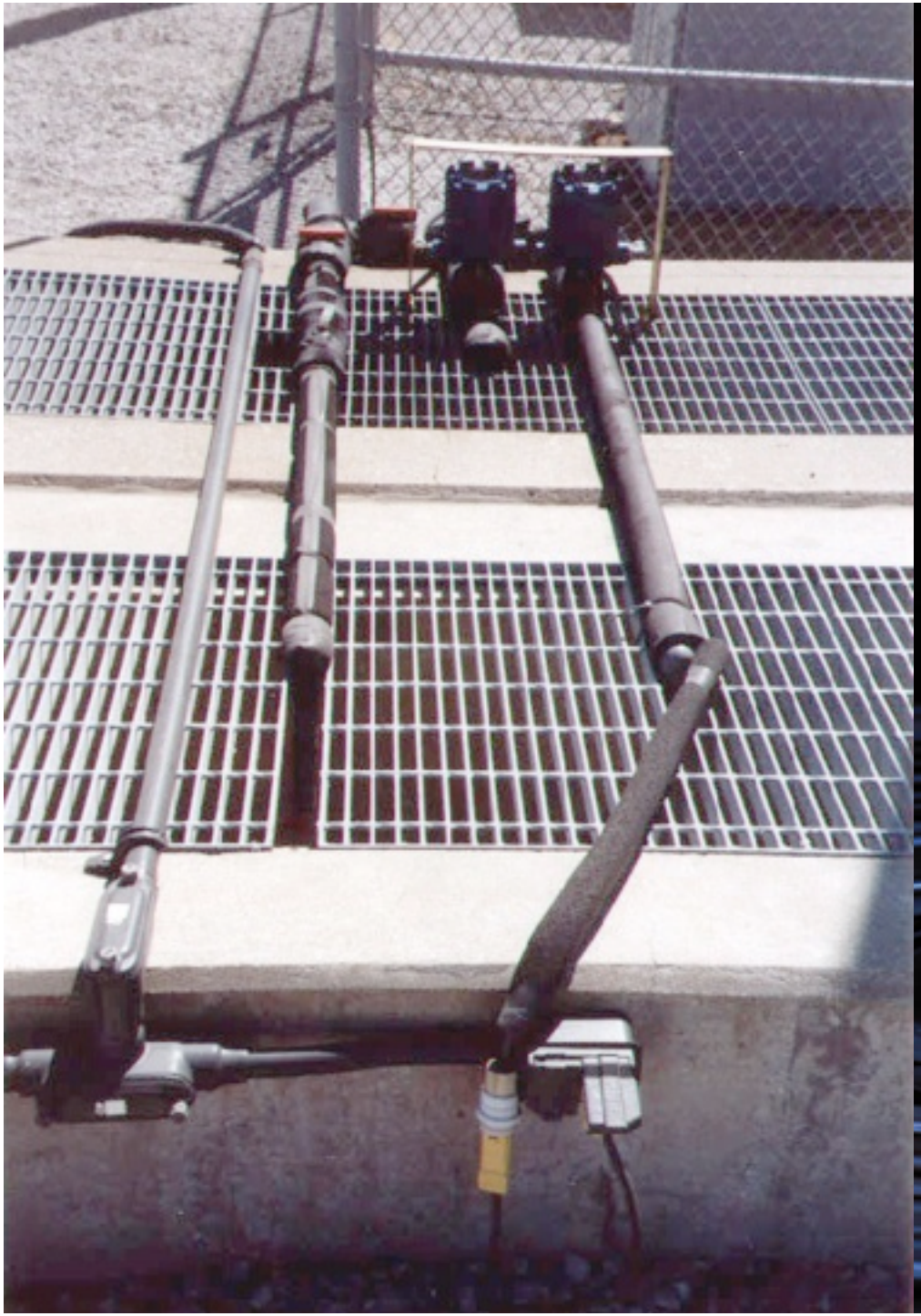

Polymeric Coagulant Feed

Polymer diluted to:

0.1 percent

(1,000 ppm)

Polymer Dose:

1 - 3 mg/l

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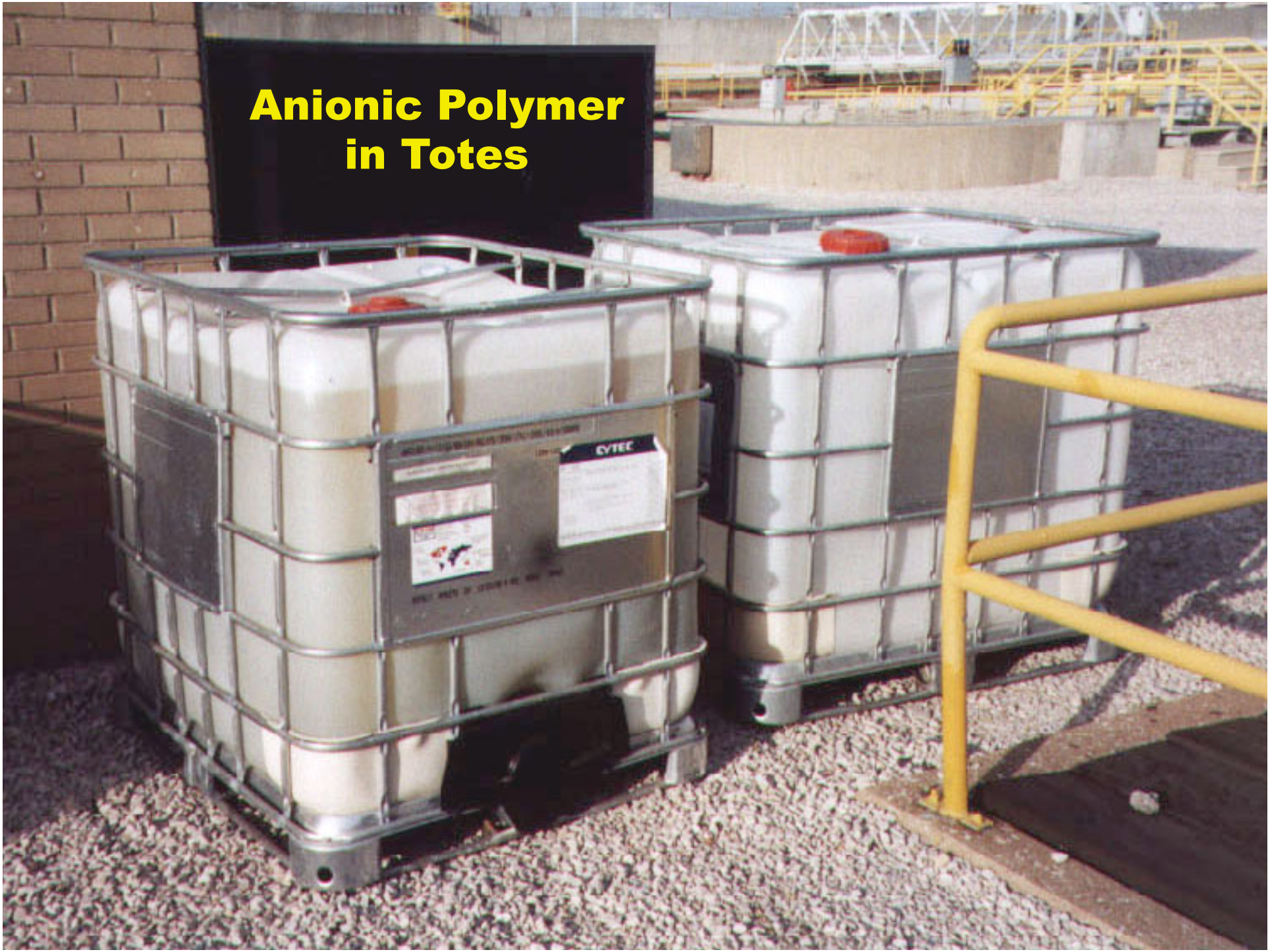

Anionic Polymer
in Totes
CYTEC

Synthetic Polyelectrolytes

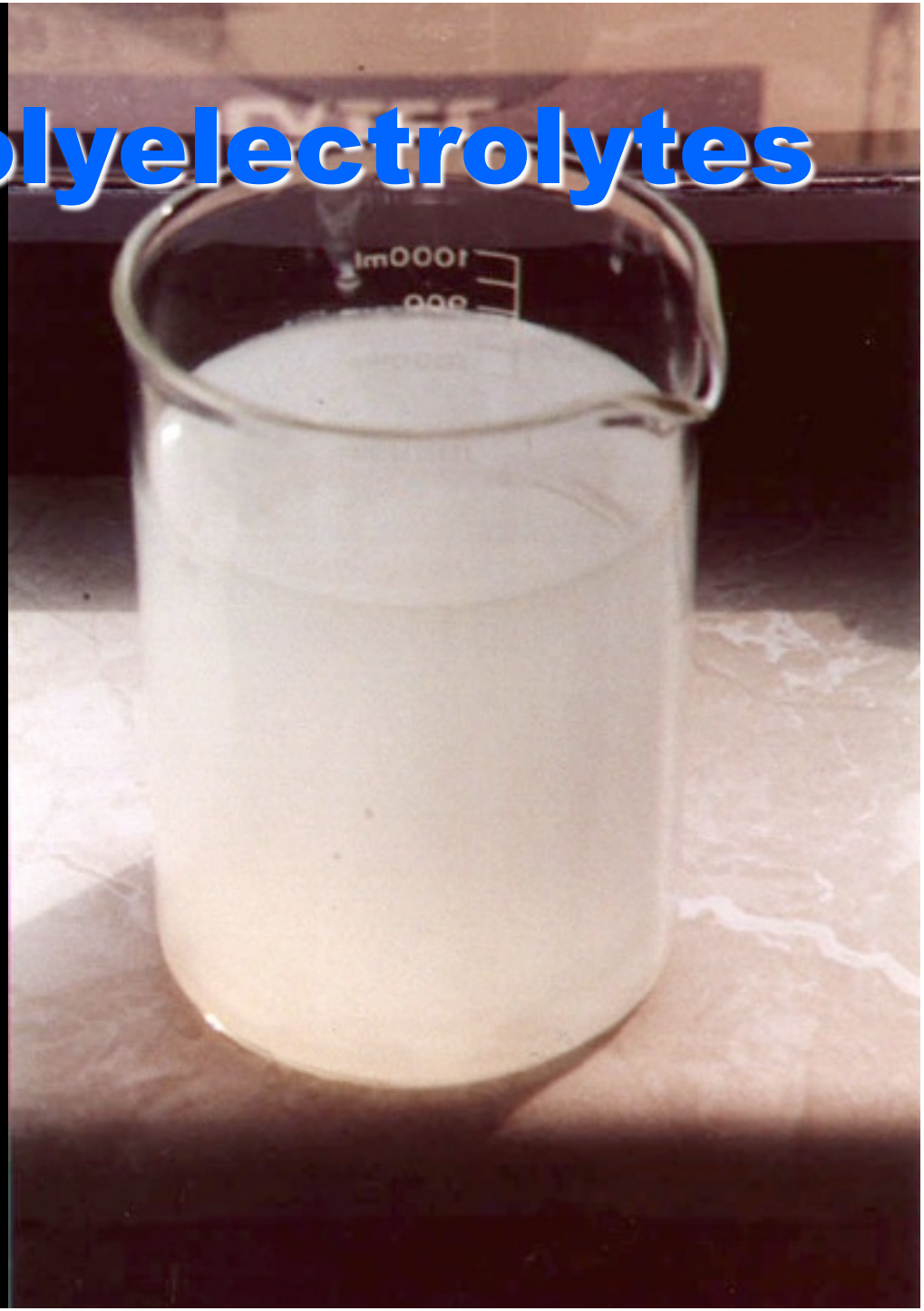
- Anionic (Negative)
- Cationic (Positive)
- Nonionic (Both)

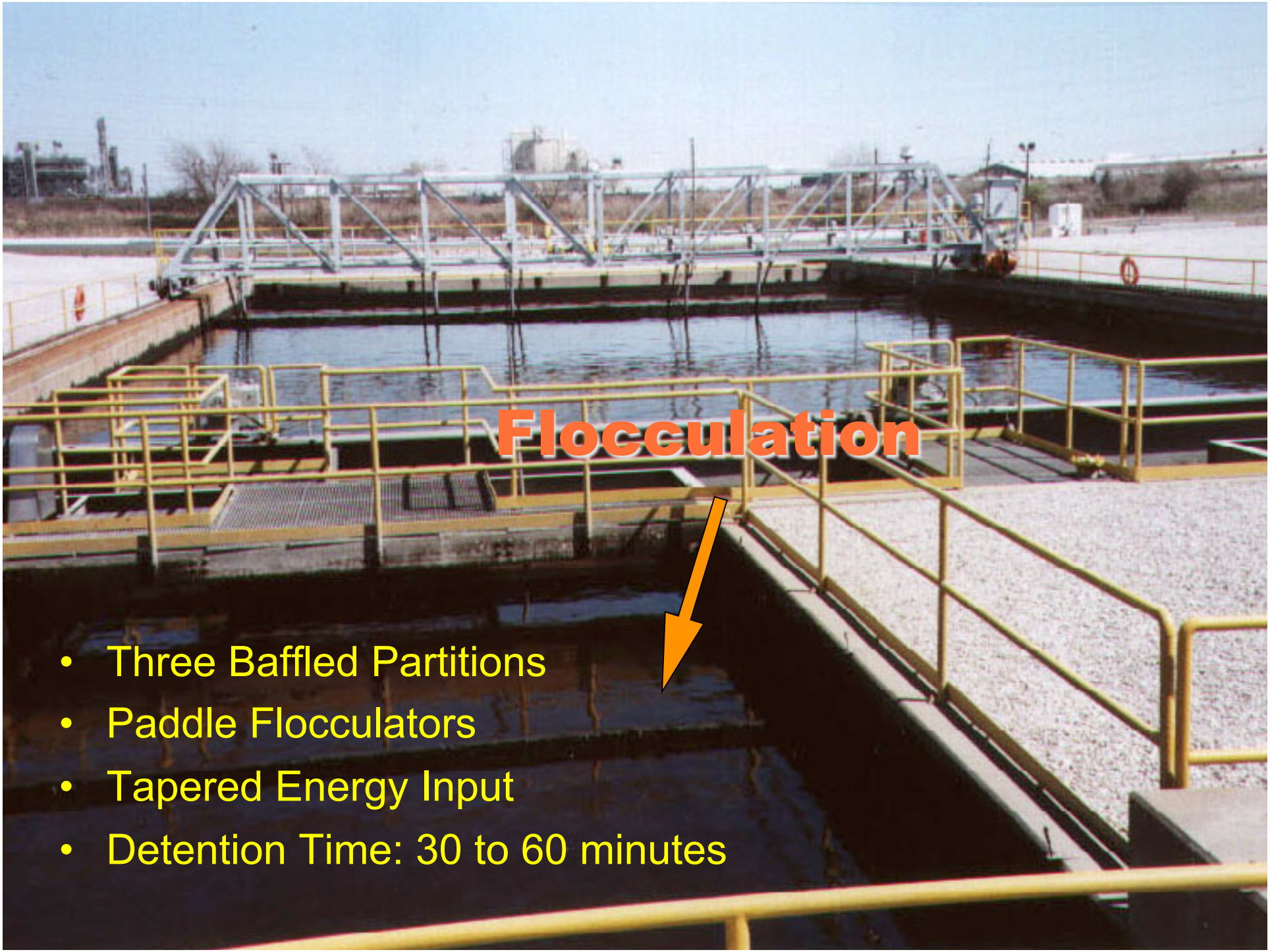
High Molecular Weight

~ 1,000,000 amu

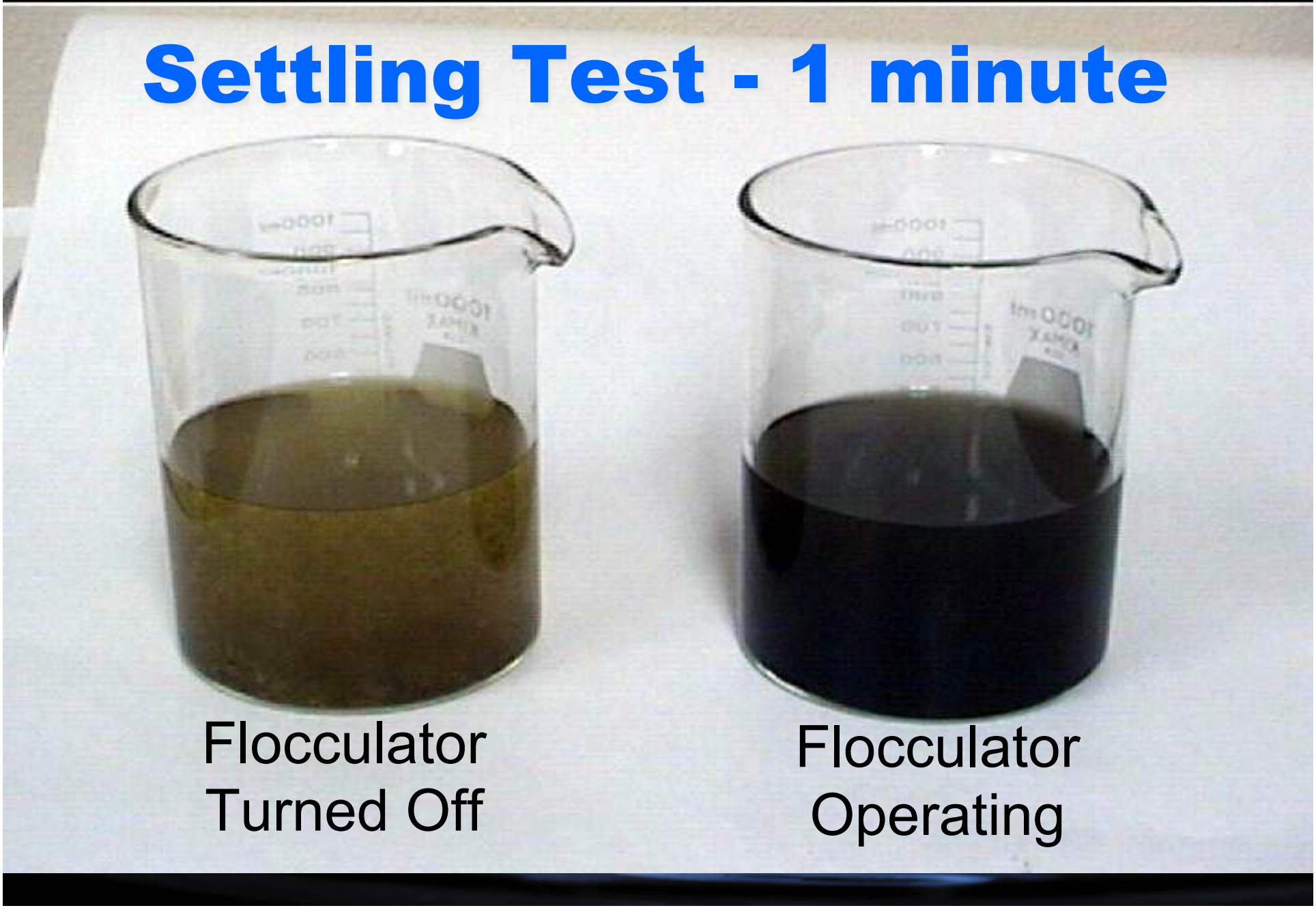
Dosage ≈ 1 mg/l

Interparticle Bridging




Flocculation
• Three Baffled Partitions
• Paddle Flocculators
• Tapered Energy Input
• Detention Time: 30 to 60 minutes

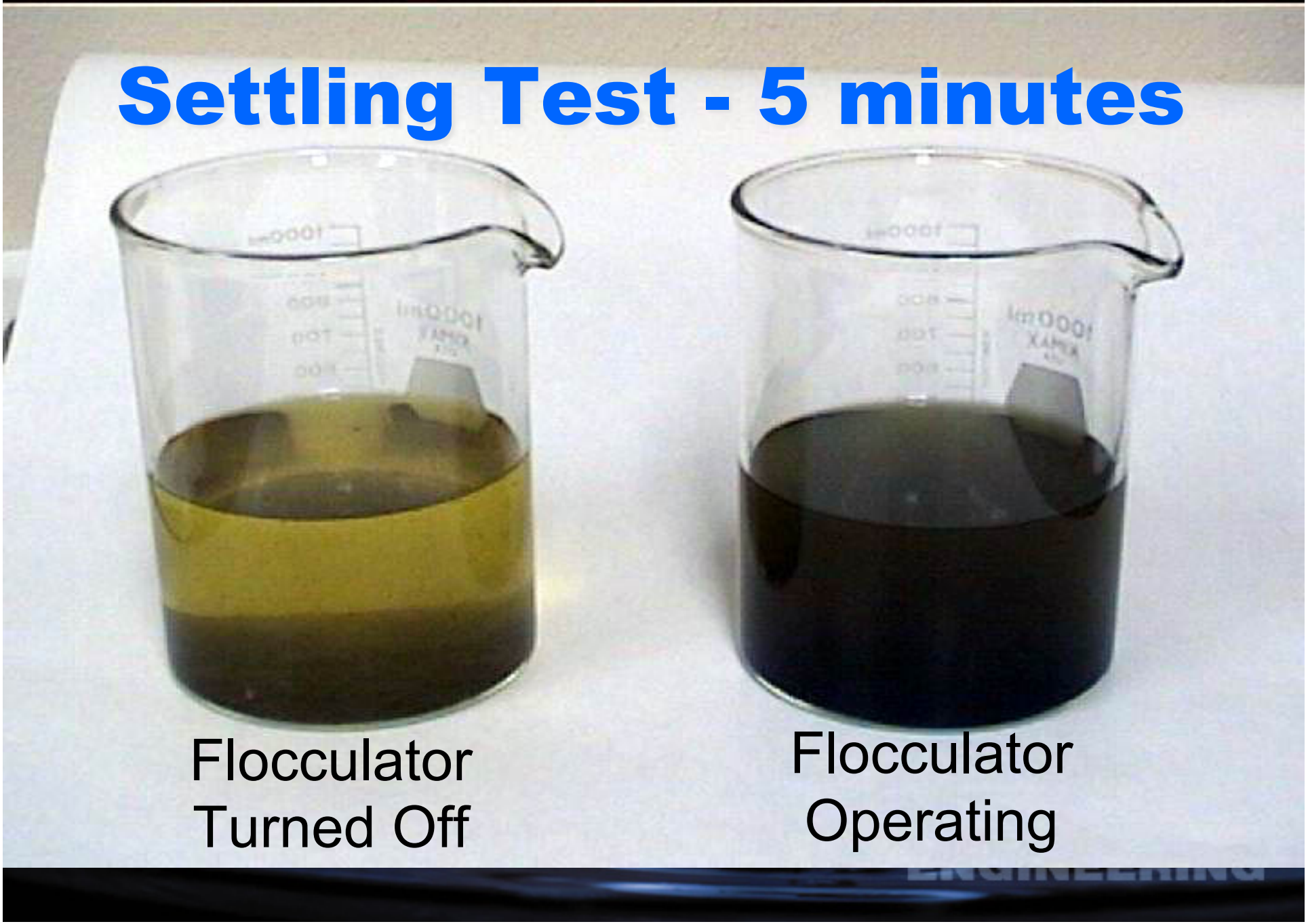
Settling Test - 1 minute



Flocculator
Turned Off

Flocculator
Operating

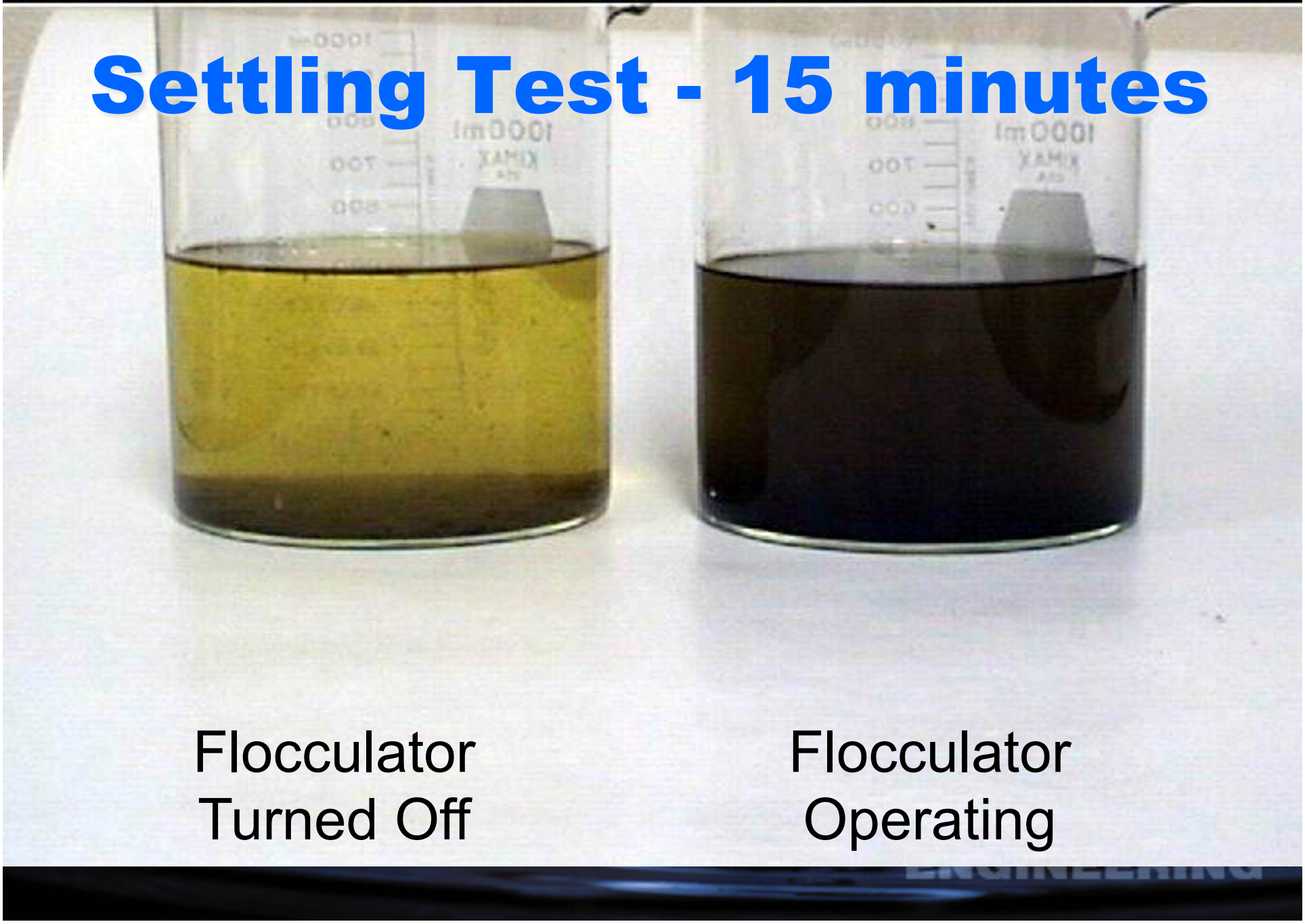
Settling Test - 5 minutes



Flocculator
Turned Off

Flocculator
Operating

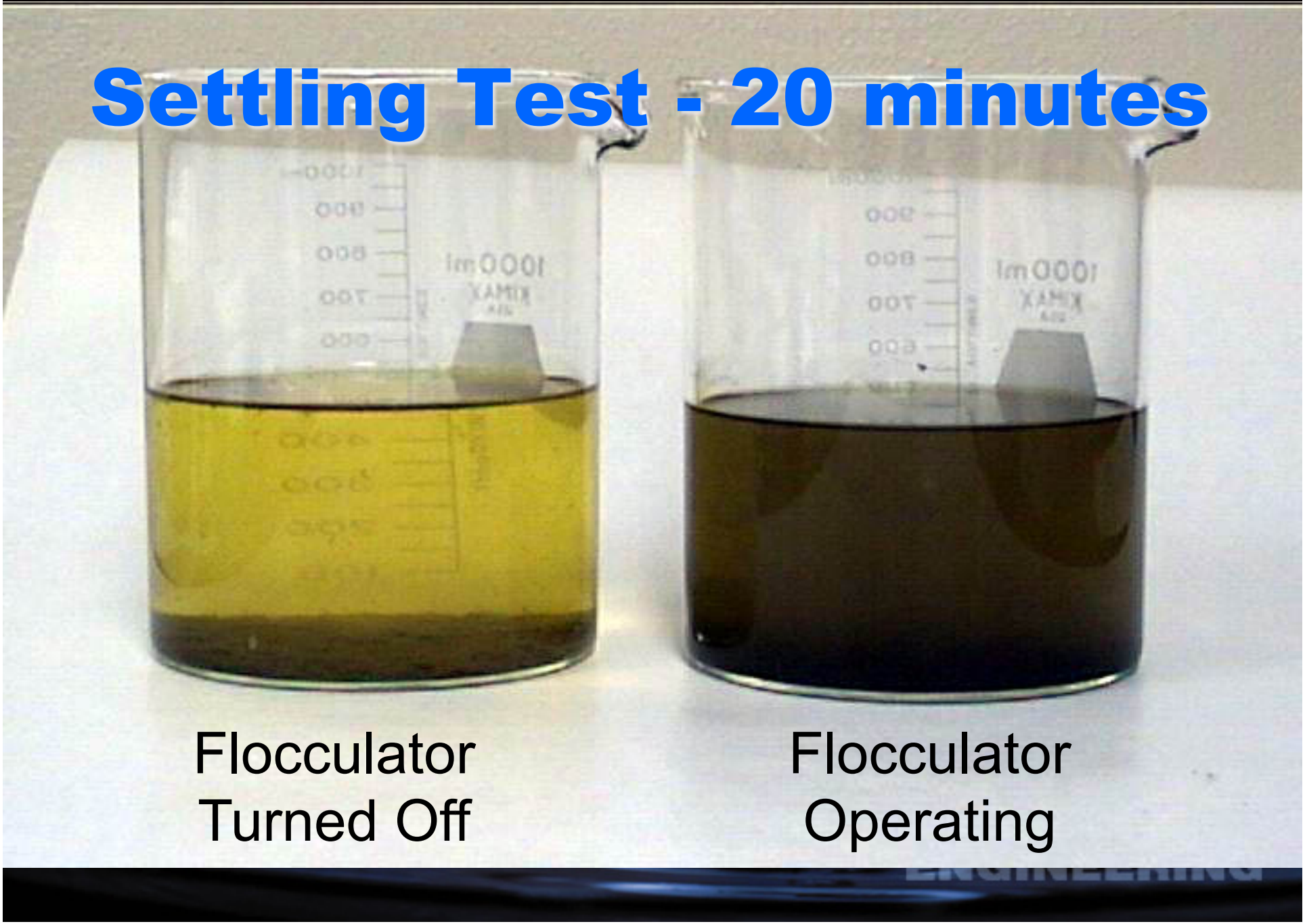
Settling Test - 15 minutes



Flocculator
Turned Off

Flocculator
Operating

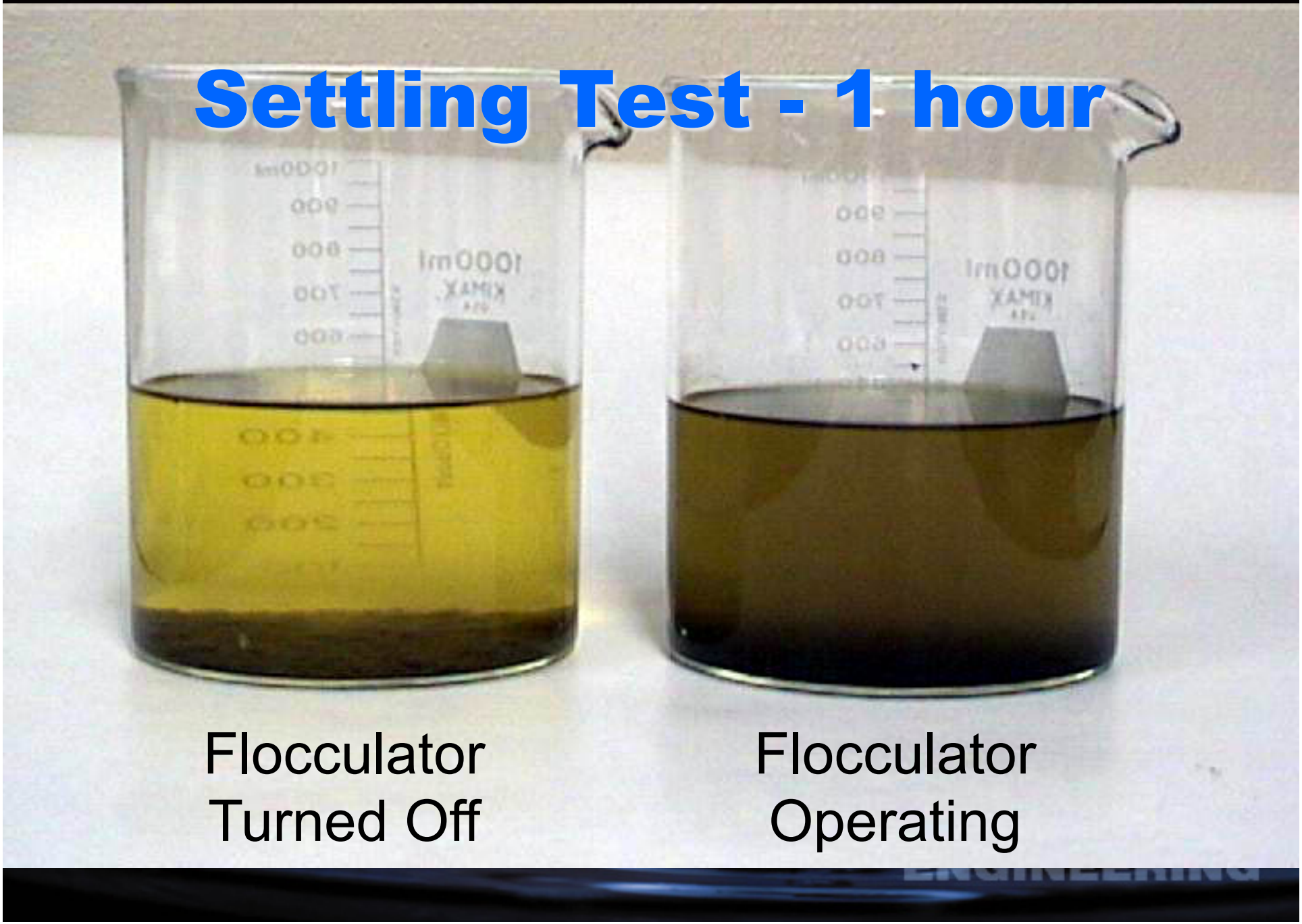
Settling Test - 20 minutes



Flocculator
Turned Off

Flocculator
Operating

Settling Test - 1 hour

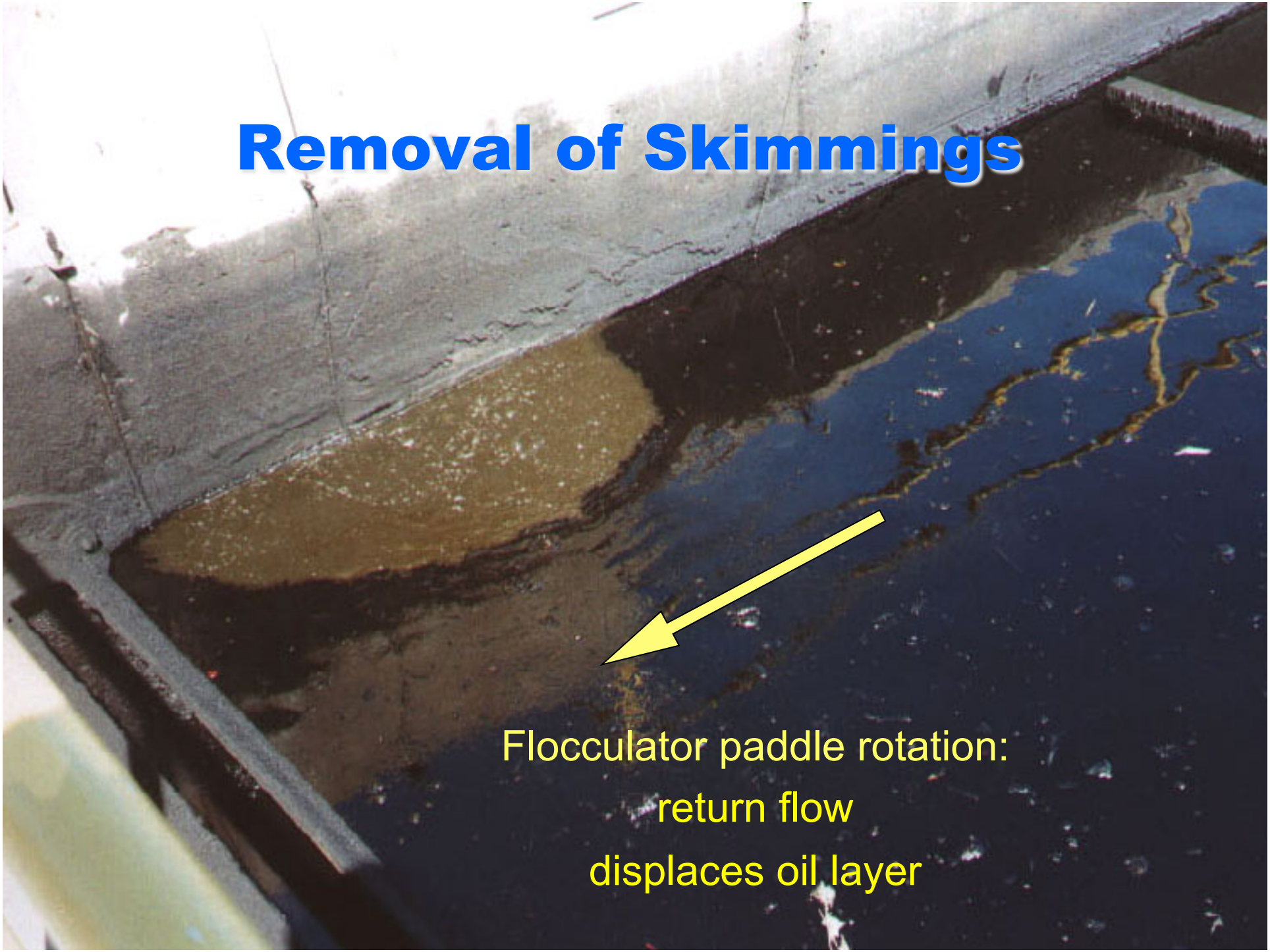


Flocculator
Turned Off

Flocculator
Operating

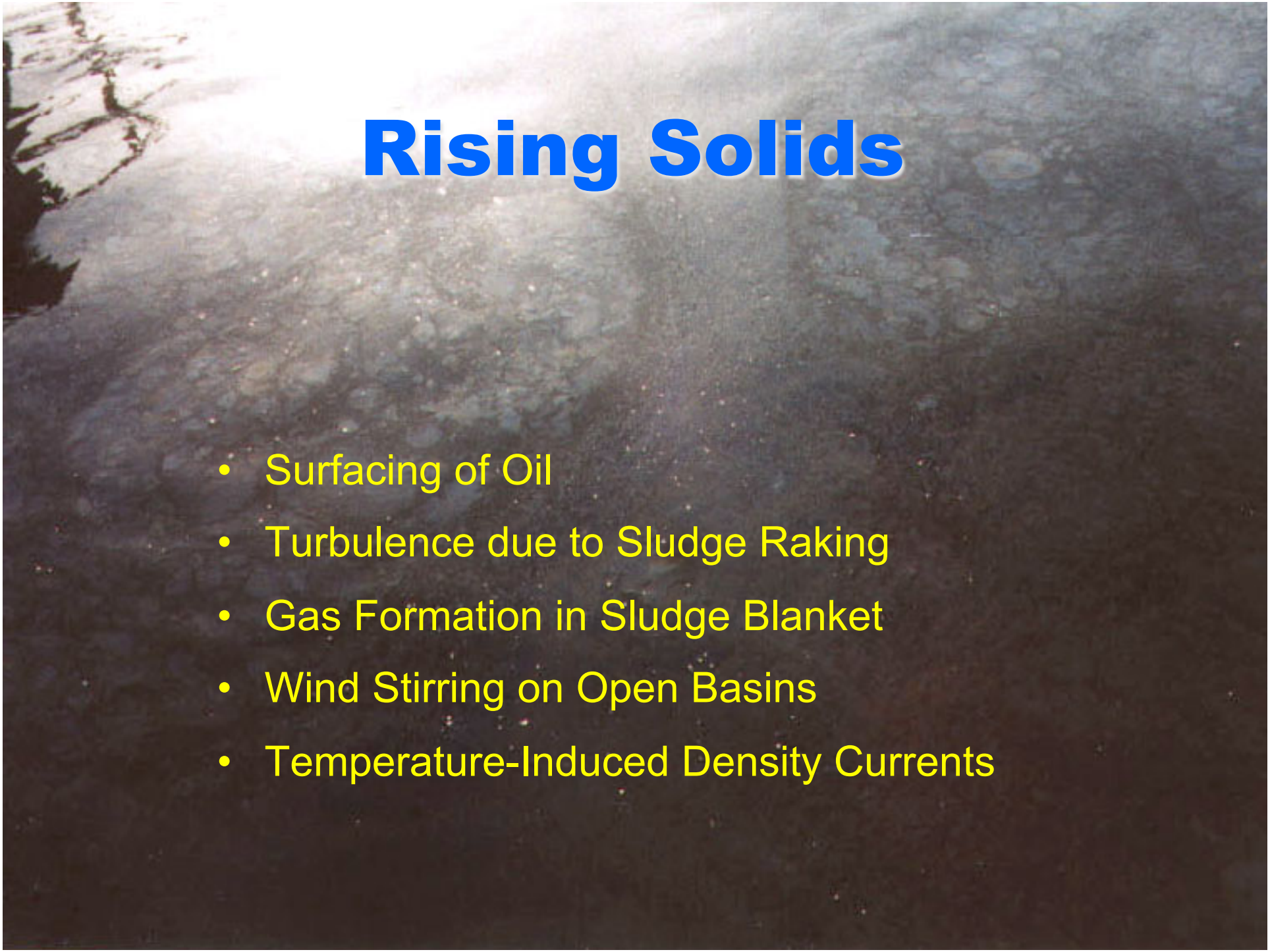
Removal of Skimmings

Removal of Skimmings



Settling Tanks

- Retention Time: > 2 hours
- Surface Loading Rate: < 1,000 gpd/sf
- Sludge Storage Hoppers
- Sludge Rake Mechanisms



Rising Solids

- Surfacing of Oil
- Turbulence due to Sludge Raking
- Gas Formation in Sludge Blanket
- Wind Stirring on Open Basins
- Temperature-Induced Density Currents

Sludge Removal Mechanism

Chain-Driven Flights

Continuous Raking

Intermittent Solids Removal

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Effluent Weirs

V-notch weirs
to minimize effect
of wind set-up and
turbulence

Serpentine launders
to ensure
overflow rate
< 20,000 gal/ft/day

Settling Tank Detention

Ideal Tank:

3 mgd flow in 0.9 mg tank: 0.3 days retention

Deviation from Ideal:

- Inlet, Outlet and Sludge Storage Zones
- Variations in Flow, Uneven Distribution
- Temperature (Density), Dead Spots
- Wind Stirring, Set Up, Seiches
- Turbulence, Sludge Blanket Upsets

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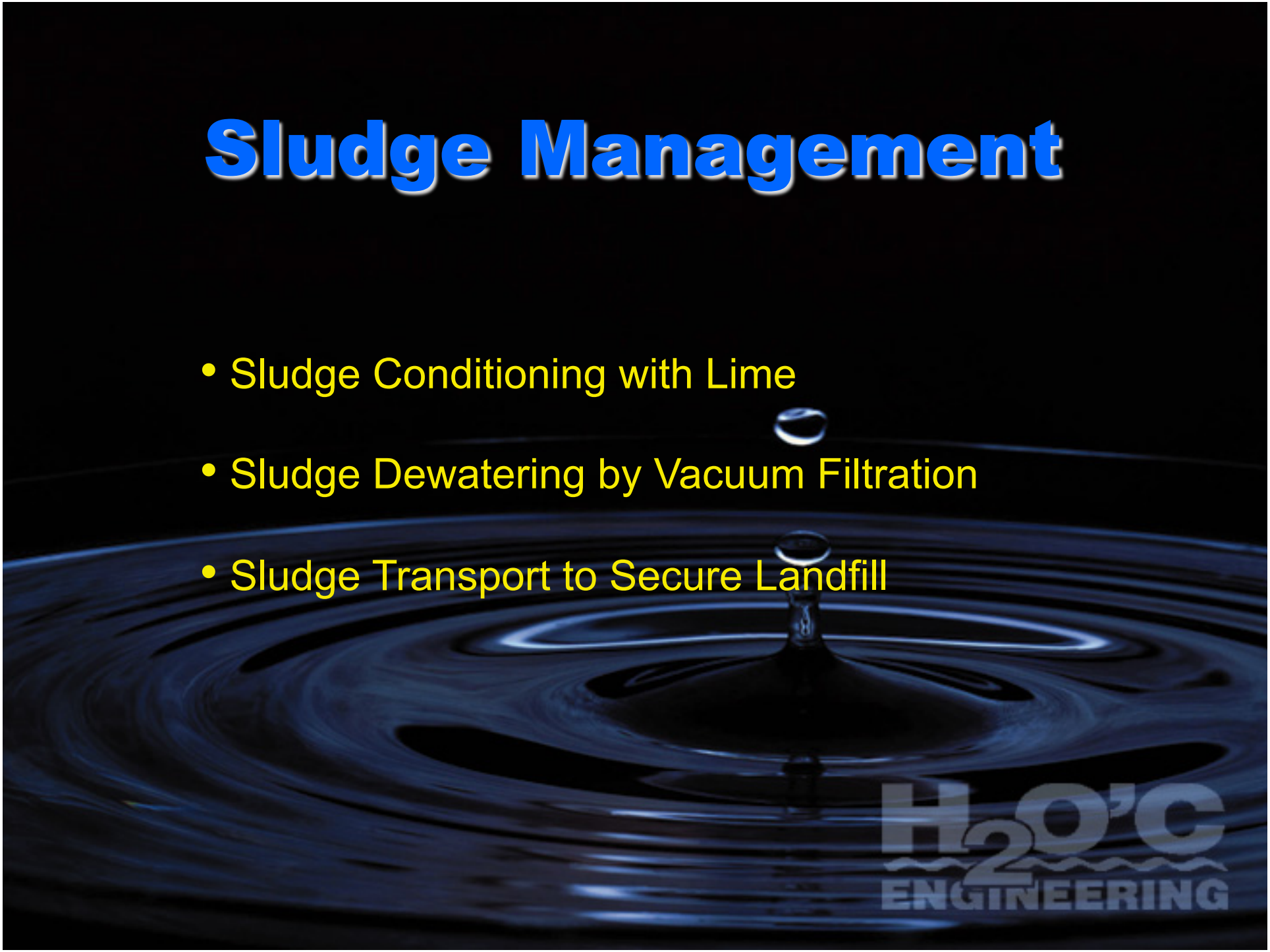
Sludge Management

- Sludge Conditioning with Lime
- Sludge Dewatering by Vacuum Filtration
- Sludge Transport to Secure Landfill



Sludge Thickening

Lime Feed:
1,300 lbs. per day

Influent Solids: 1.4 %

Effluent Solids: 9.0 %

Filtrate: pH 11

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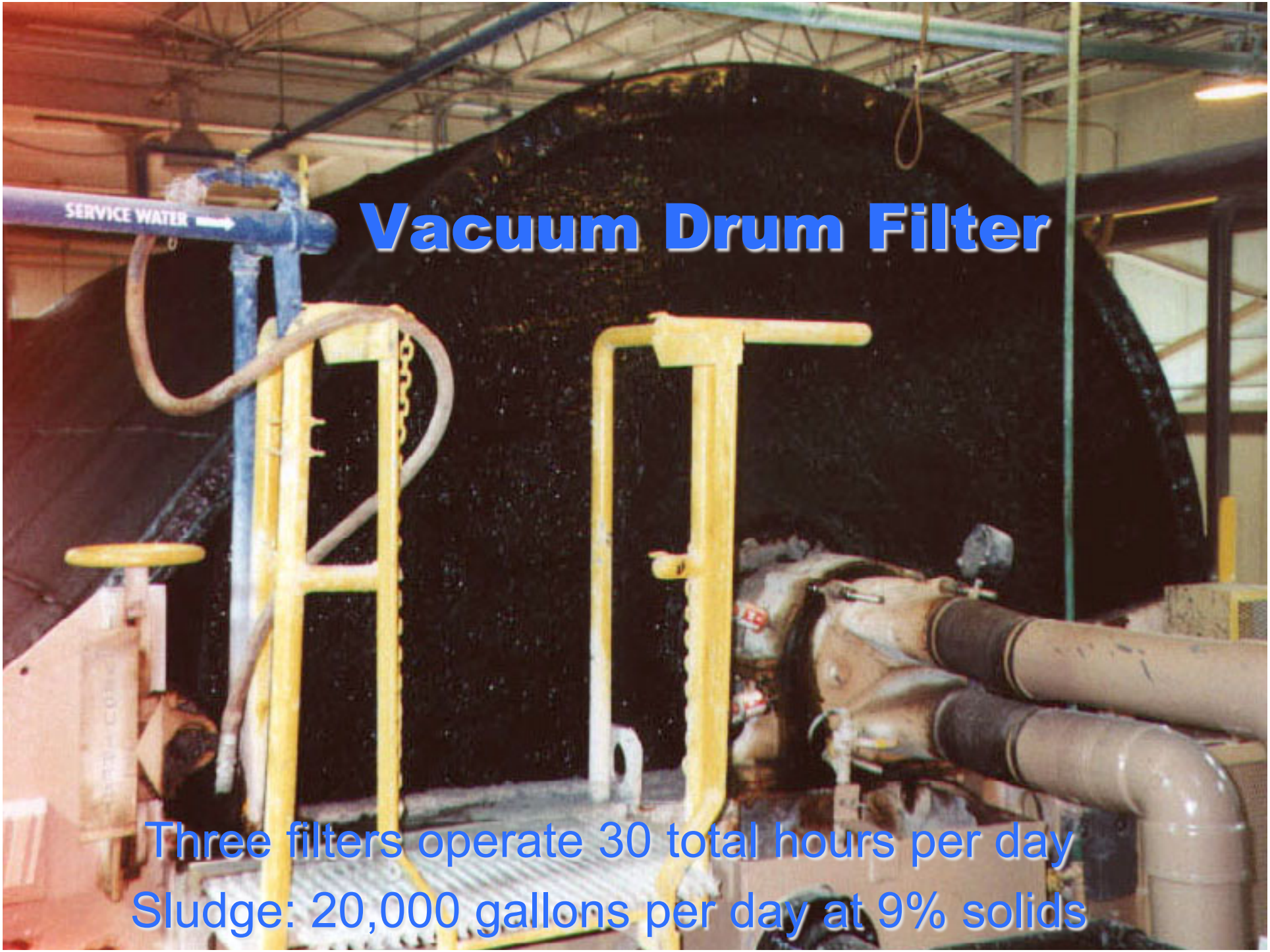


Vacuum Drum Filter

Three filters operate 30 total hours per day

Sludge: 20,000 gallons per day at 9% solids


Capillary Suction Time:
200 seconds (raw sludge)
10 seconds (conditioned)


Filter Cake

Filter Cake on Conveyer

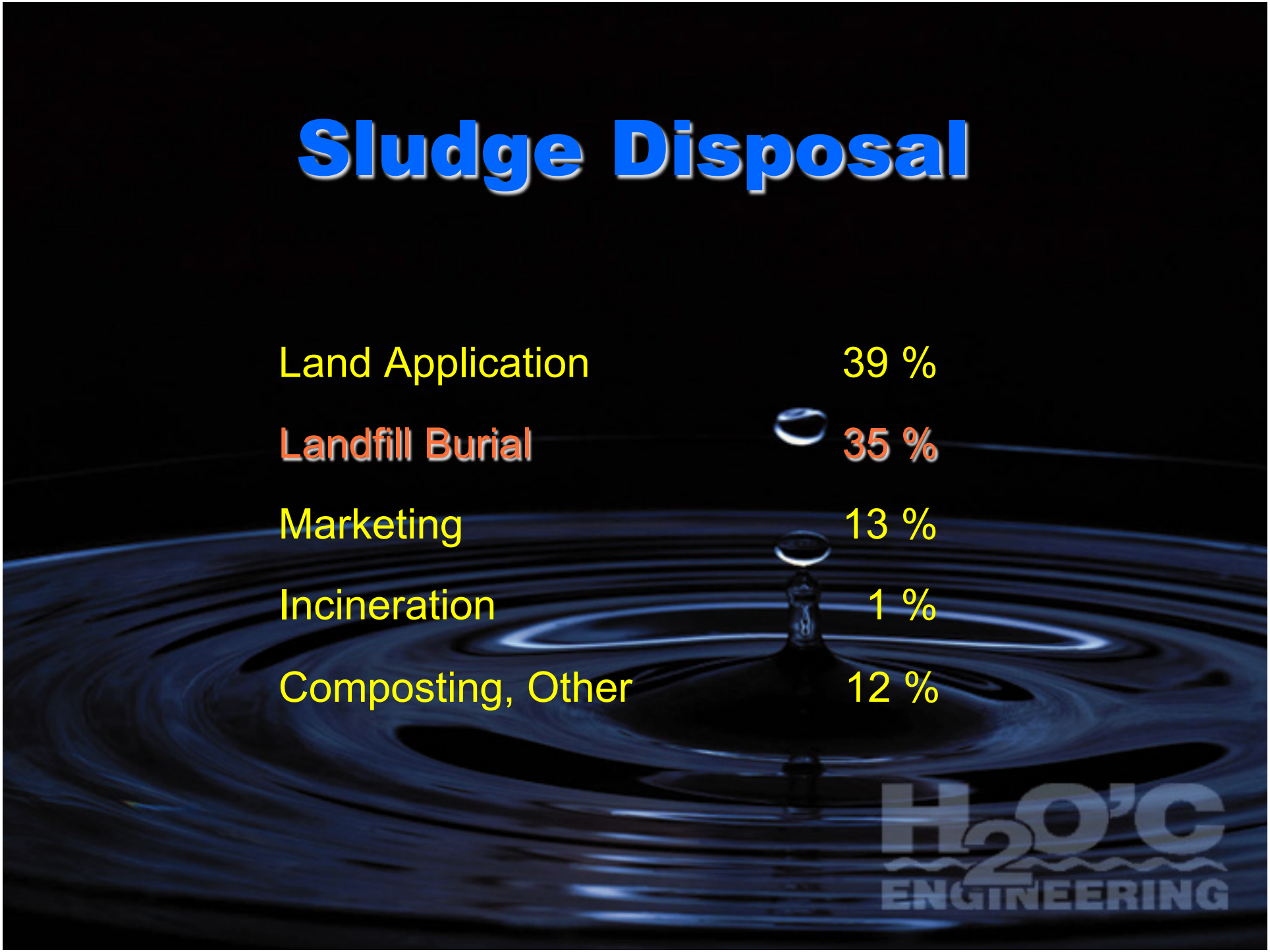
Solids increased from
9% to 27%

Three-fold sludge volume reduction

29 cu. yards/day

Sludge Disposal

Land Application	39 %
Landfill Burial	35 %
Marketing	13 %
Incineration	1 %
Composting, Other	12 %



Sludge Heavy Metals

Precipitated metals are recovered in sludges which are then unsuitable for disposal on land.

	Zn	Cu	Cd
		ppm, dry weight	
Dayton, OH	8,390	6,020	830
Monterey, CA	3,400	720	< 200
Cincinnati, OH	9,000	4,200	< 40

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Summary

Industrial Waste Pretreatment includes:

Screening; Skimming of Grease and Oil; Grit Removal

Equalization of Flow, Blending, Acid-Base Neutralization

Precipitation of Toxic Metals with alkalis (e.g., Lime)

Removal of Precipitated Metals requires:

Addition of Coagulant, Rapid Mix to disperse chemicals

Flocculation (slow mix) to form settleable floc, Sedimentation

Disposal of Metal-Bearing Sludges requires:

Sludge thickening for volume reduction, improved filterability

Transport of dewatered solids to secure landfill

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