REINHOLD ENVIRONMENTAL Ltd.

2019 REINHOLD Round Table Presentation

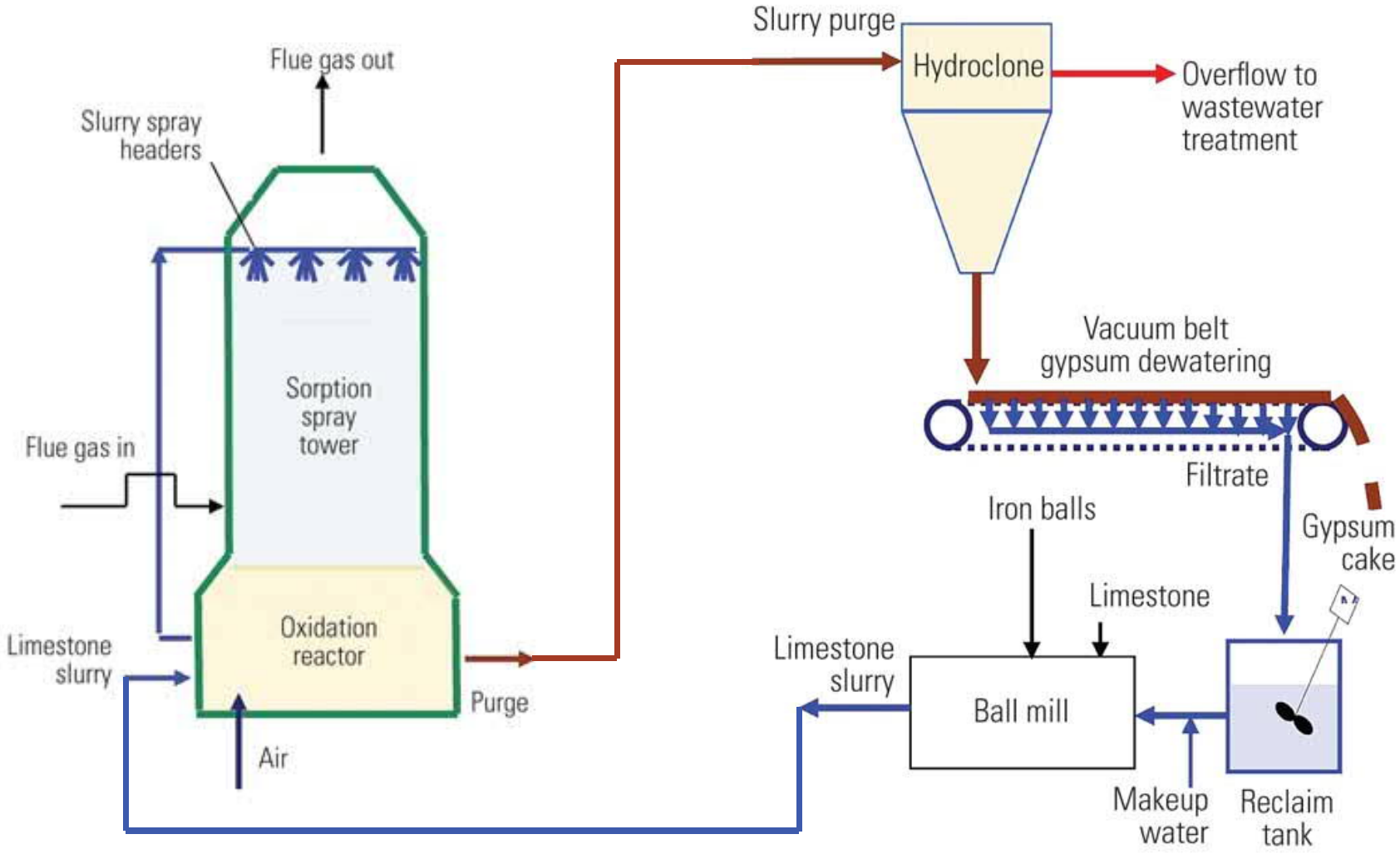
June 24 & 25, 2019, in Birmingham, Alabama / Hosted by Southern Company

Wet Flue Gas Desulfurization Wastewater Physical / Chemical Treatment Lessons Learned

Presented by:
Ralph A. Cutler, PE
President
June 2019

WesTech

FGD Basics



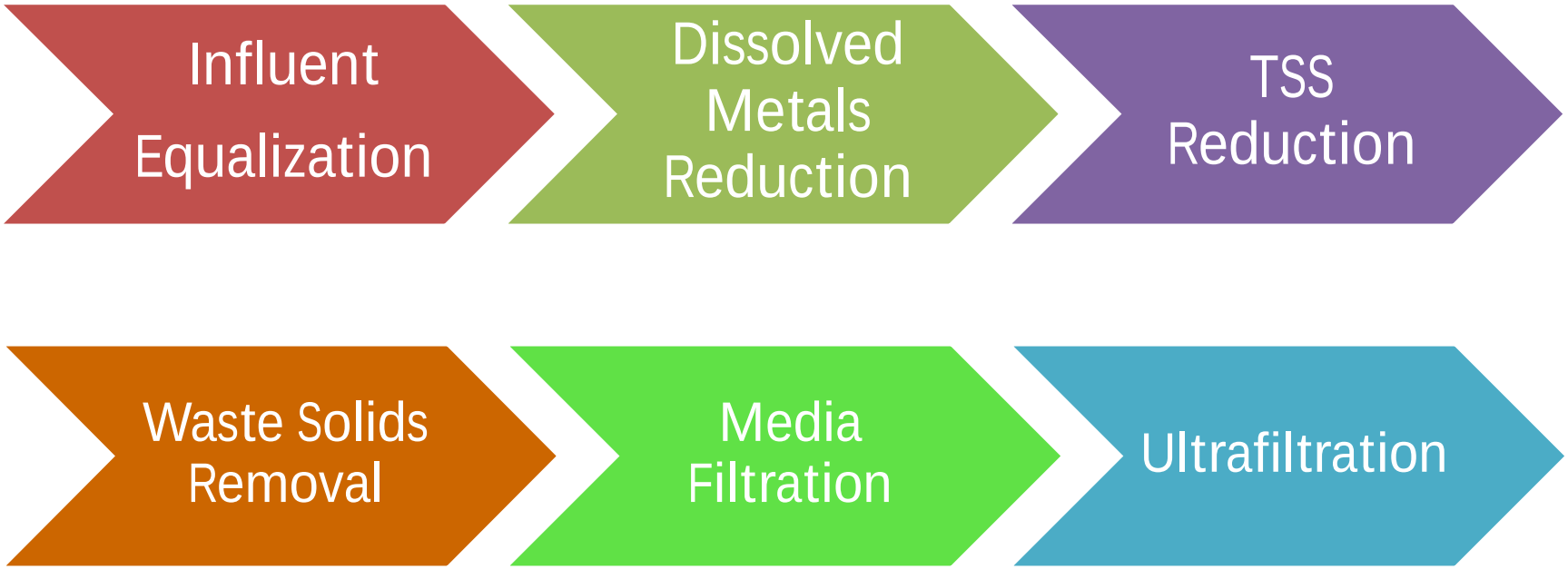
Source: PowerMag, Flue Gas Desulfurization Wastewater Treatment Primer

Typical Influent Design Criteria FGD Blowdown

Flow Rate	Approximately 100,000 gpd
Temperature	125F to 140F
pH	4.5 to 9 (Typically <7)
Total Suspended Solids	1.4% to 17%
Sulfate	1,500 to 8,000 mg/l
Chloride	1,000 to 28,000 mg/l
Calcium	750 to 4,000 mg/l
Magnesium	1,100 to 4,800 mg/l
Sodium	670 to 4,800 mg/l
TKN (Total Kjeldahl Nitrogen)	2.4 to 58 mg/l as Nitrogen

Source: PowerMag, Flue Gas Desulfurization Wastewater Treatment Primer

Overview of FGD Wastewater Phys/Chem Treatment



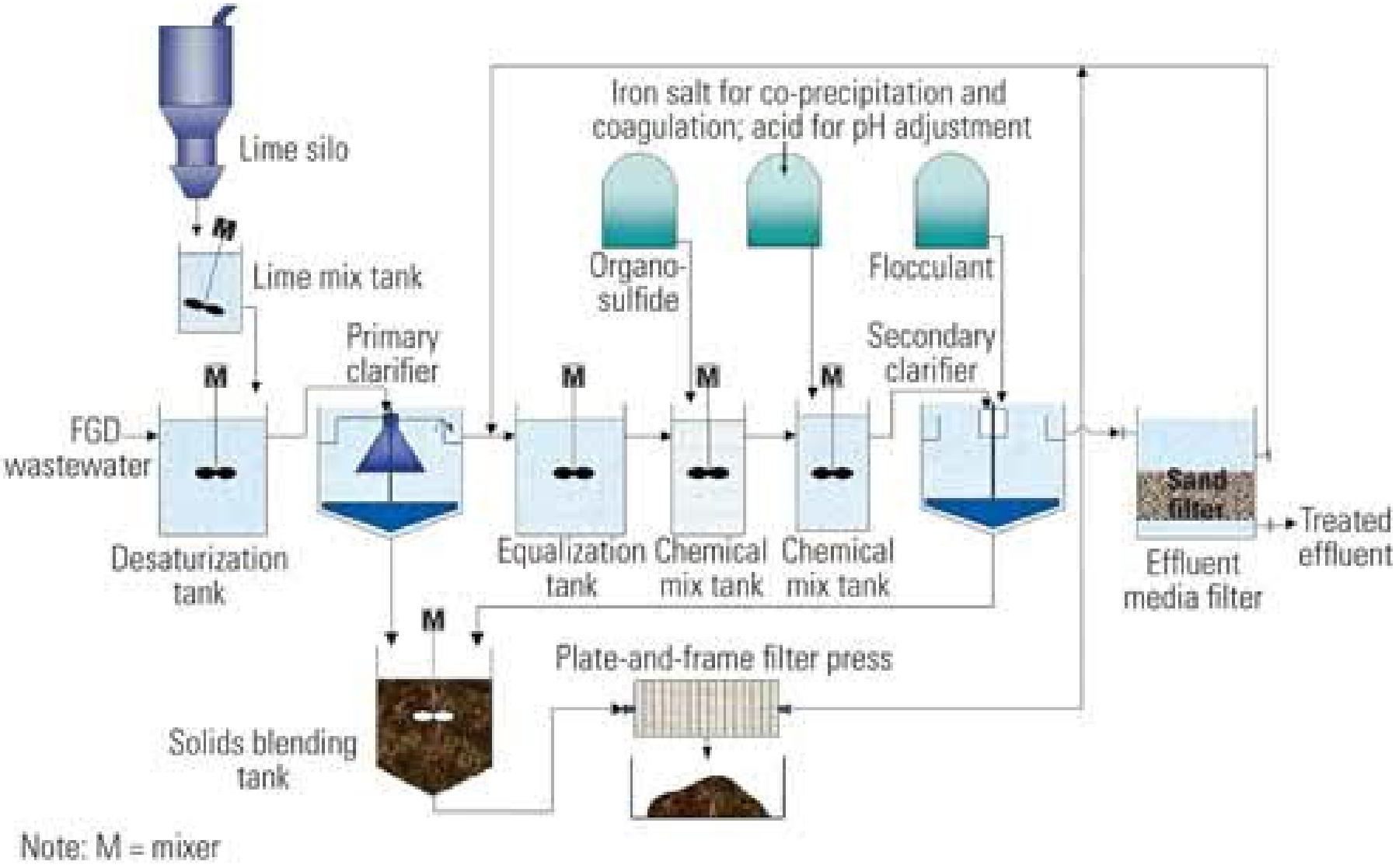
Current ELG Effluent Concentrations

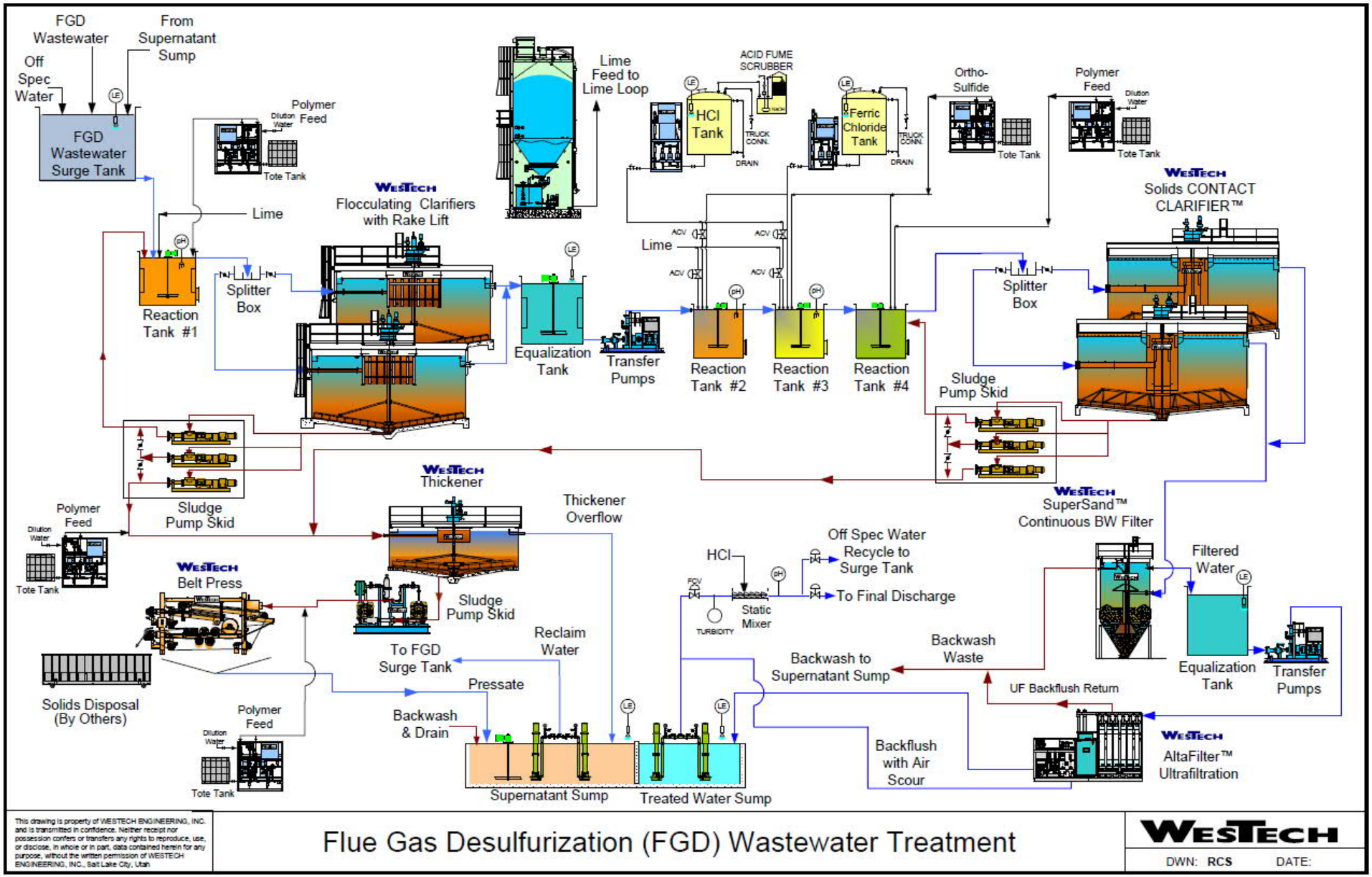
(g)(1)(i) *FGD wastewater.* Except for those discharges to which paragraph (g)(2) or (g)(3) of this section applies, the quantity of pollutants in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed in the table following this paragraph (g)(1)(i). Dischargers must meet the effluent limitations for FGD wastewater in this paragraph by a date determined by the permitting authority that is as soon as possible beginning November 1, 2020, but no later than December 31, 2023. These effluent limitations apply to the discharge of FGD wastewater generated on and after the date determined by the permitting authority for meeting the effluent limitations, as specified in this paragraph.

	BAT Effluent limitations	
Pollutant or pollutant property	**Maximum for any 1 day**	**Average of daily values for 30 consecutive days shall not exceed**
Arsenic, total (ug/L)	11	8
Mercury, total (ng/L)	788	356
Selenium, total (ug/L)	23	12
Nitrate/nitrite as N (mg/L)	17.0	4.4

Source: Code of Federal Regulations Title 40 Part 423.13

Physical Chemical Treatment




FGD Wastewater
From Supernatant Sump
Off Spec Water
FGD Wastewater Surge Tank
Polymer Feed
Dilution Water
Tote Tank
Lime
Reaction Tank #1
Splitter Box
WesTech
Flocculating Clarifiers with Rake Lift
Lime Feed to Lime Loop
Equalization Tank
Transfer Pumps
ACID FUME SCRUBBER
HCl Tank
TRUCK CONN.
DRAIN
Ferric Chloride Tank
Ortho-Sulfide
Polymer Feed
Lime
Reaction Tank #2
Reaction Tank #3
Reaction Tank #4
Splitter Box
WesTech
Solids CONTACT CLARIFIER™
Sludge Pump Skid
WesTech
Thickener
Thickener Overflow
Sludge Pump Skid
WesTech
SuperSand™ Continuous BW Filter
Polymer Feed
Tote Tank
WesTech
Belt Press
Solids Disposal (By Others)
To FGD Surge Tank
Reclaim Water
Pressate
Backwash & Drain
Polymer Feed
Tote Tank
HCl
Static Mixer
TURBIDITY
Off Spec Water Recycle to Surge Tank
To Final Discharge
Backwash to Supernatant Sump
Backwash Waste
UF Backflush Return
Backflush with Air Scour
Supernatant Sump
Treated Water Sump
Filtered Water
Equalization Tank
Transfer Pumps
WesTech
AltaFilter™ Ultrafiltration
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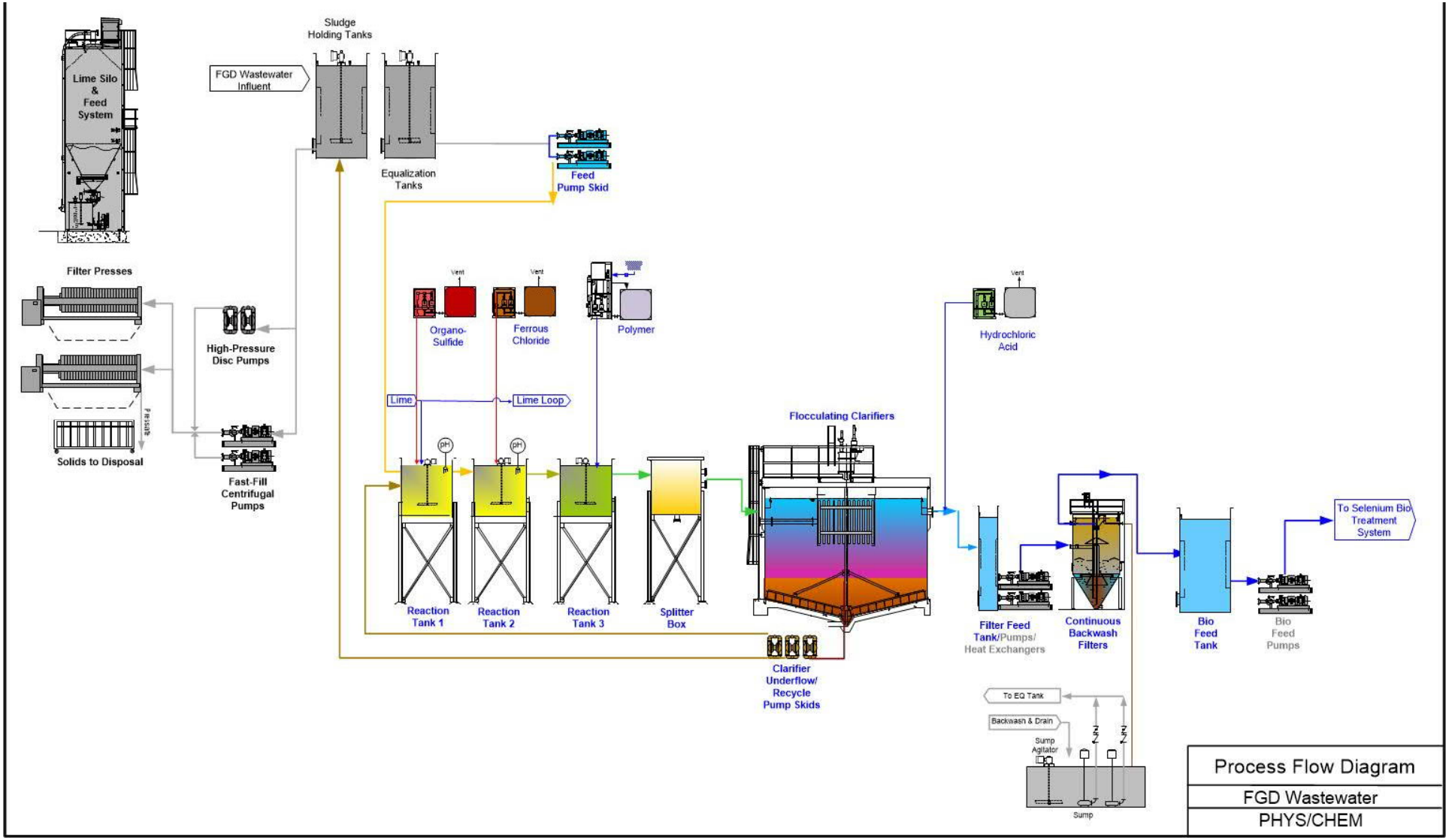
Flue Gas Desulfurization (FGD) Wastewater Treatment
WesTech
DWN: RCS
DATE:

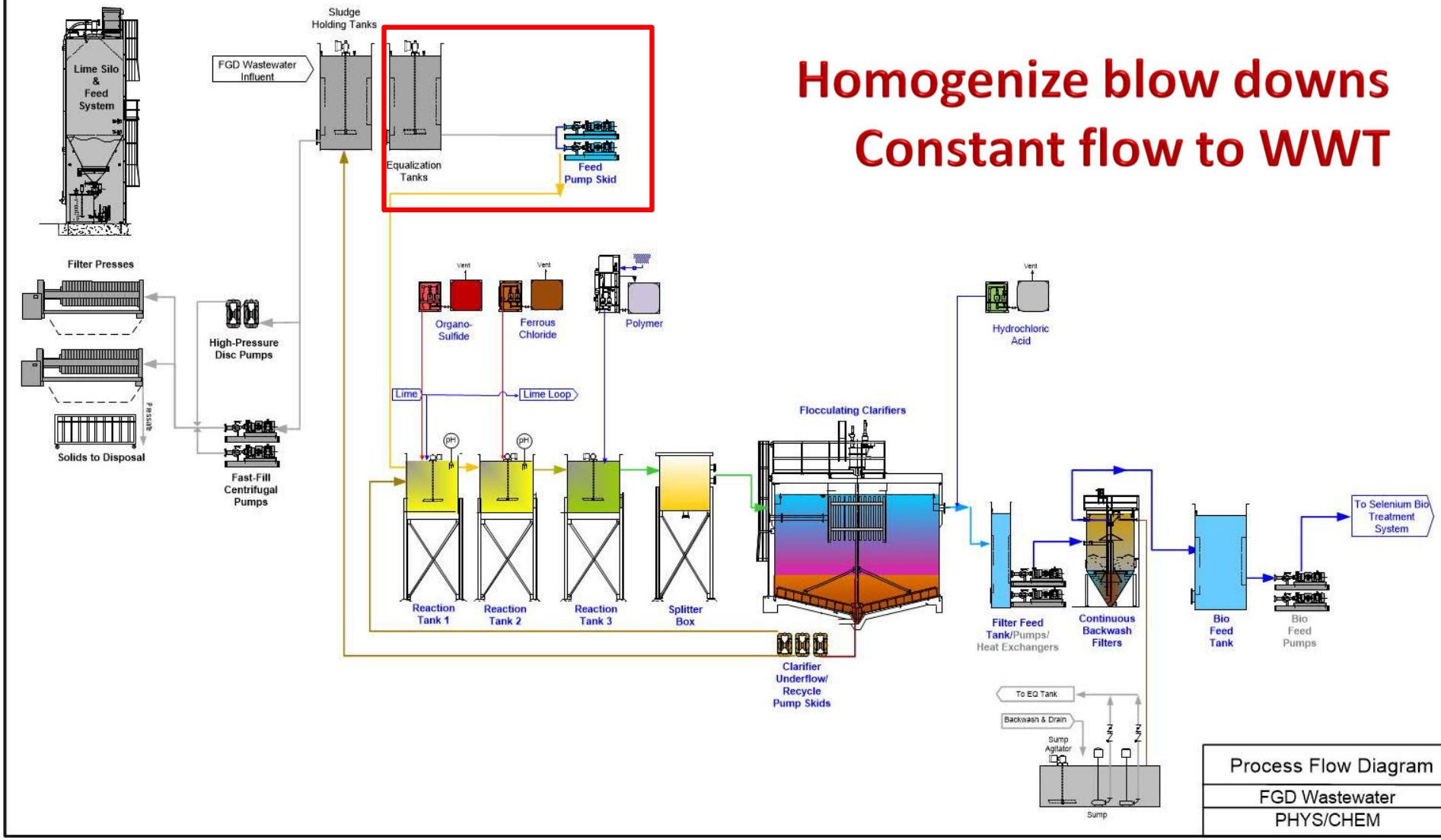
FGD Wastewater
Typical Process Flow Diagram



Influent Equalization

Dissolved Metals Reduction

TSS Reduction

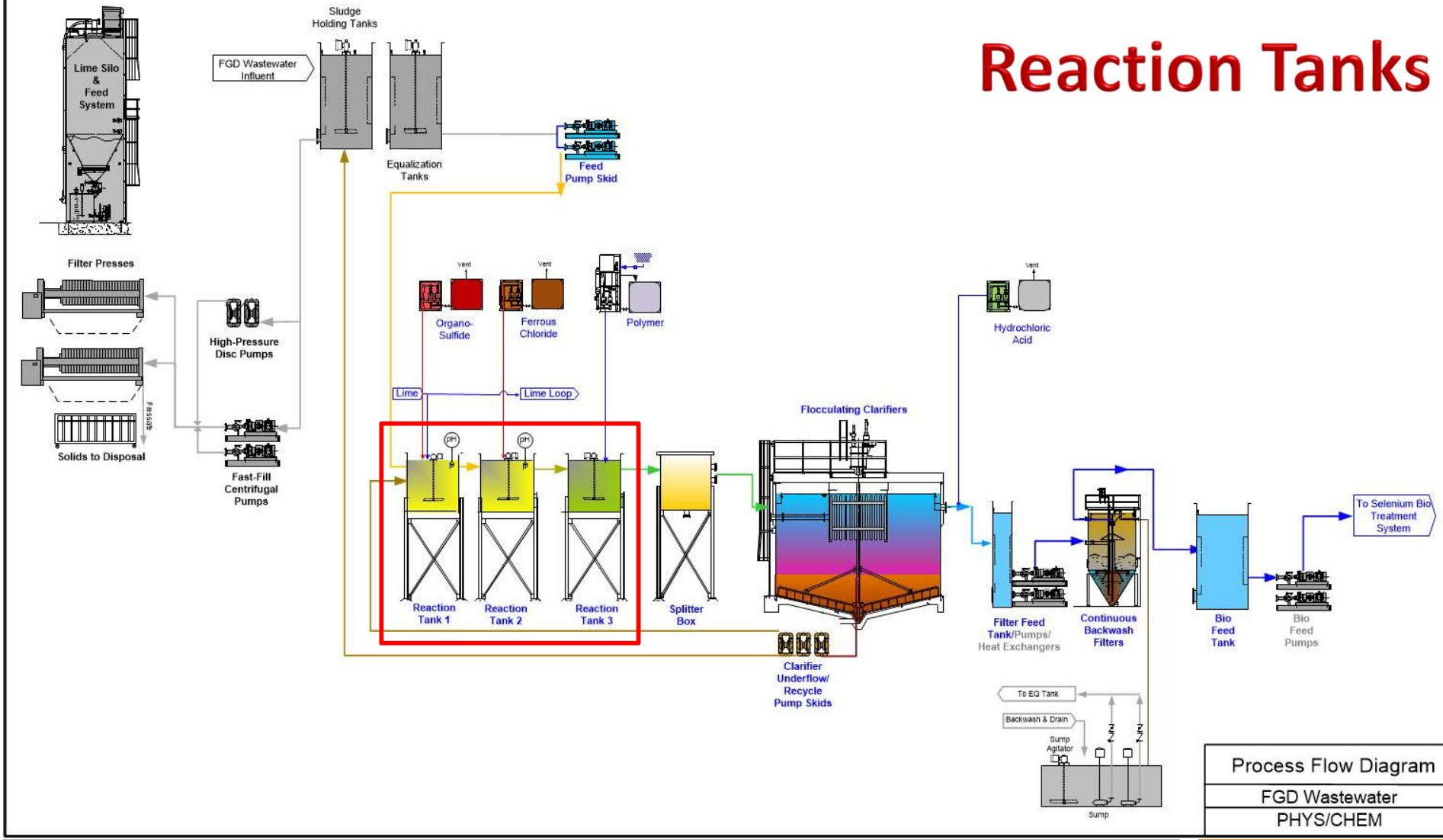


Influent Equalization

Dissolved Metals Reduction

TSS Reduction

Reaction Tanks



Process Flow Diagram

FGD Wastewater

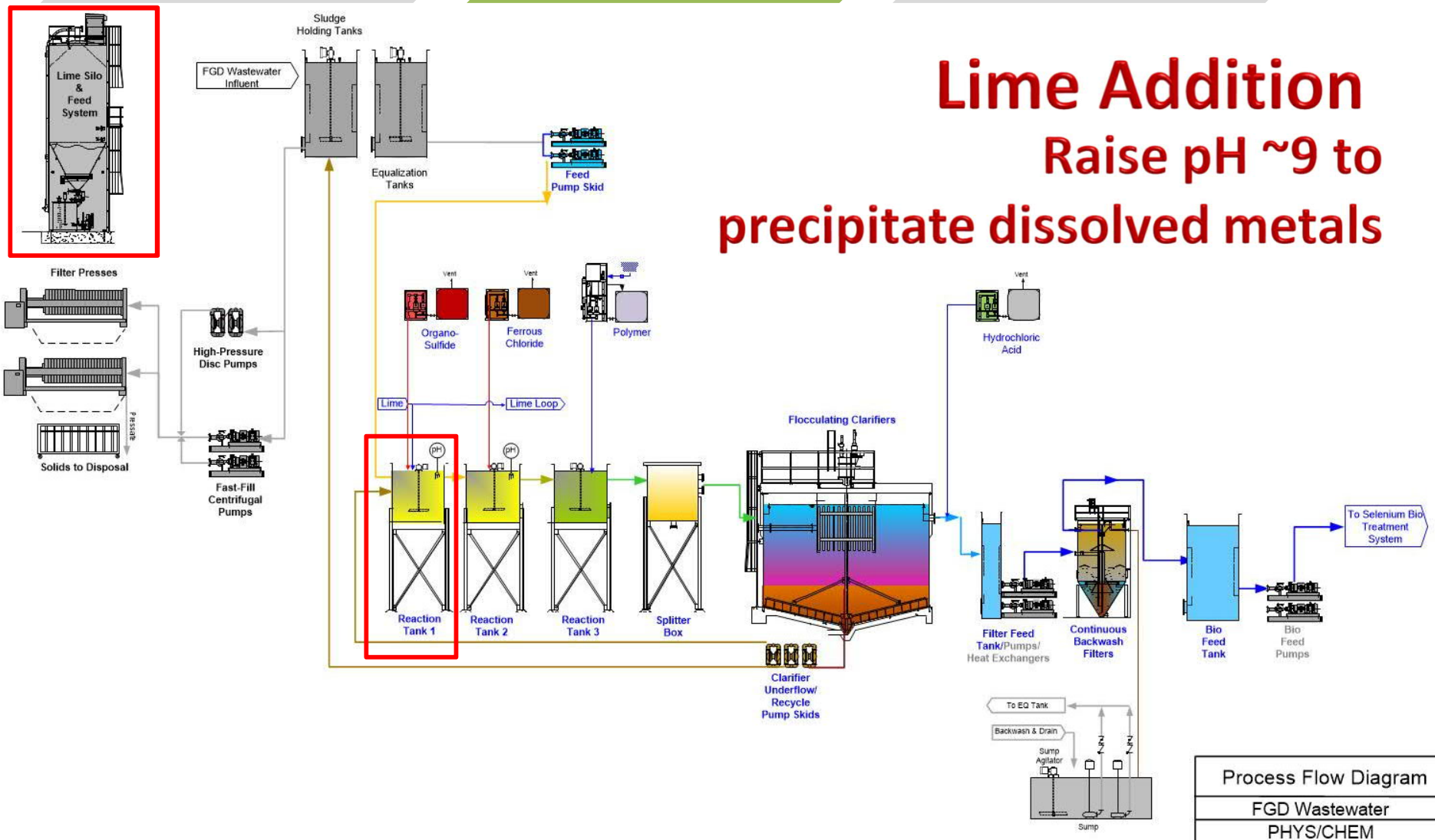
PHYS/CHEM

Reaction Tanks & Agitators

Influent Equalization

Dissolved Metals Reduction

TSS Reduction



Lime Addition

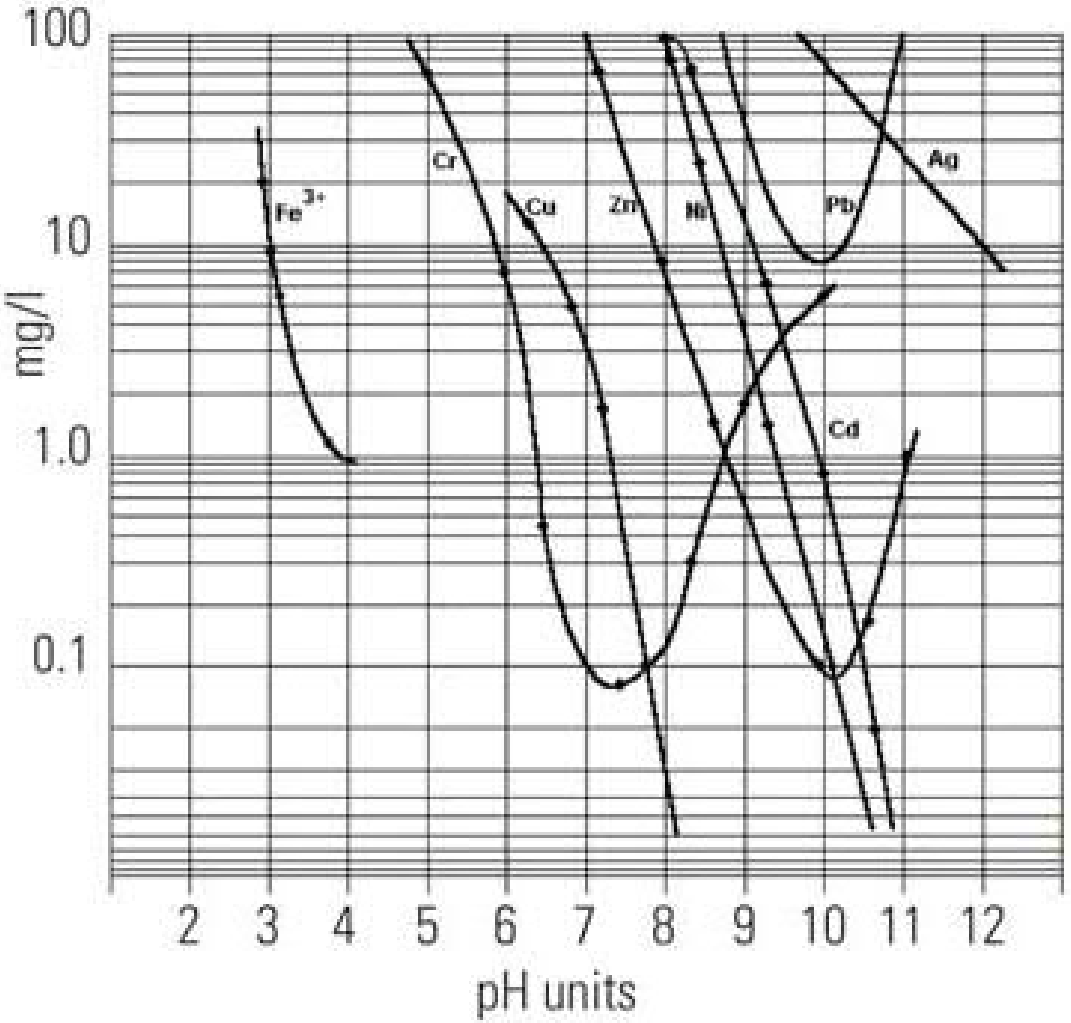
Raise pH ~9 to precipitate dissolved metals

Process Flow Diagram

FGD Wastewater

PHYS/CHEM

Solubility of cationic metal hydroxides as a function of pH



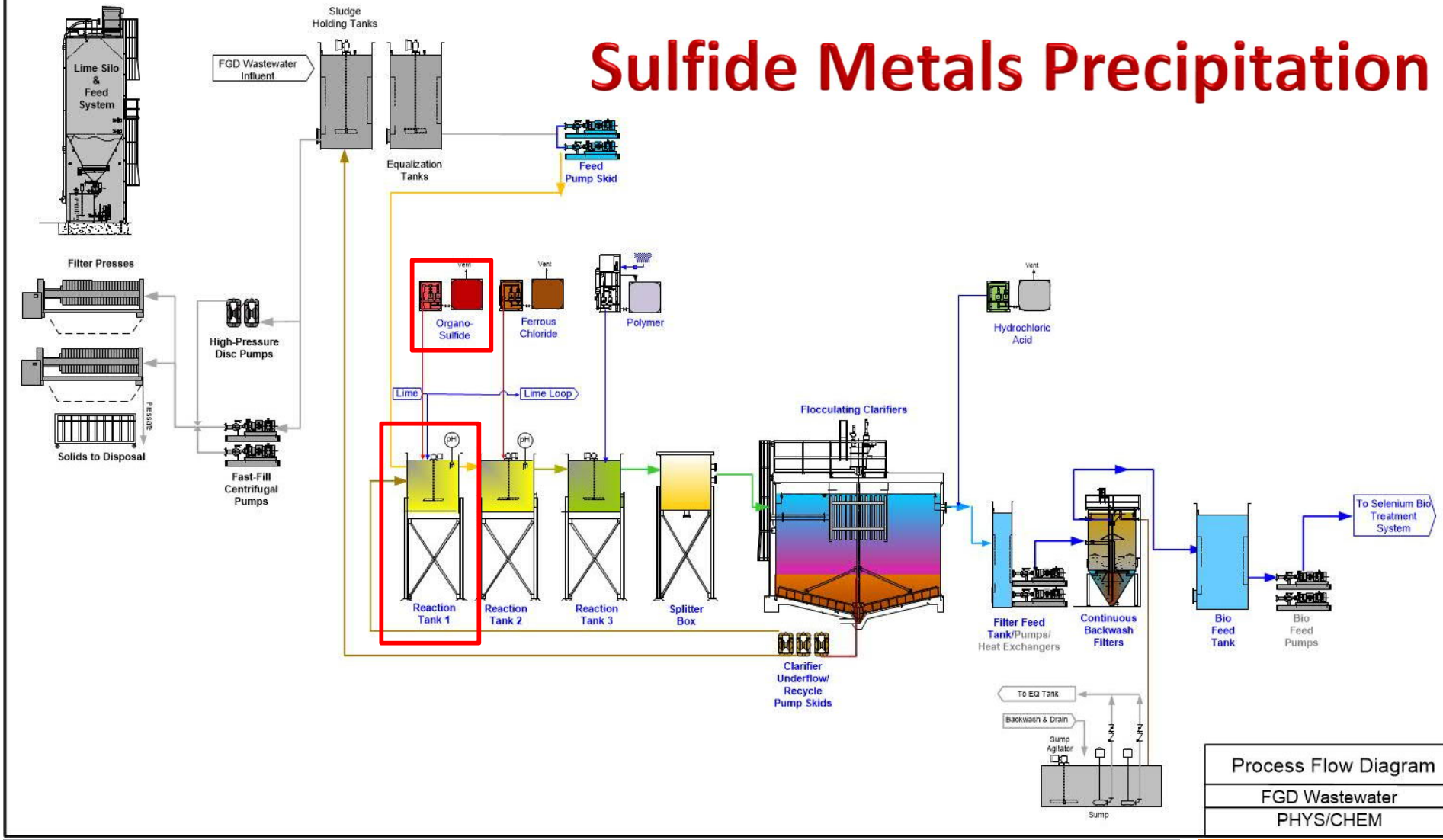
Lime Addition

Influent Equalization

Dissolved Metals Reduction

TSS Reduction

Sulfide Metals Precipitation



Process Flow Diagram

FGD Wastewater

PHYS/CHEM

Sulfide Precipitation

- Metal sulfide compounds have very low solubility
- Adding organo-sulfide allows for solid mercury-sulfide compounds to form

http://web.deu.edu.tr/atiksu/ana52/ychem02.html

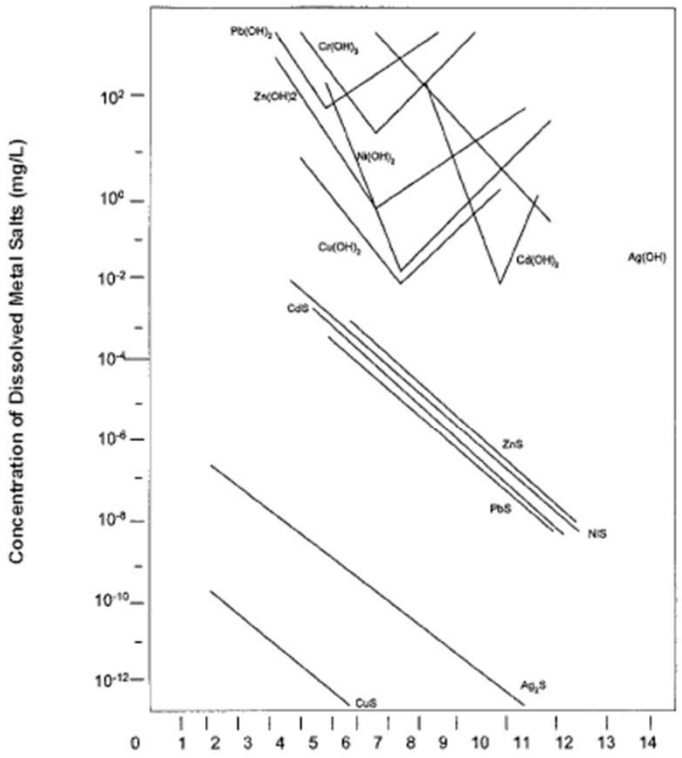
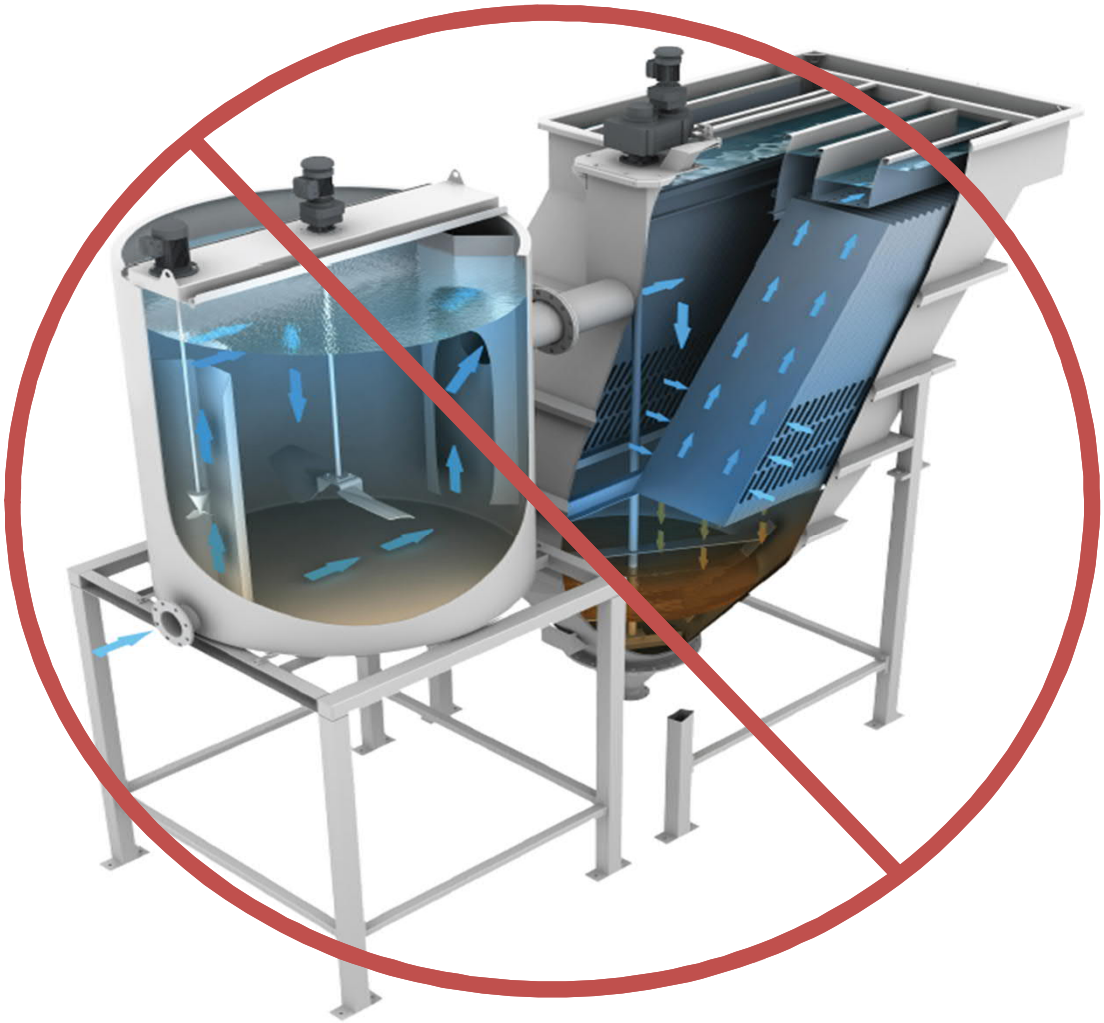


Figure 2-2. Solubility of metal hydroxides and sulfides as a function of pH (*x*-axis) (source: EPA 625/8-80-003).

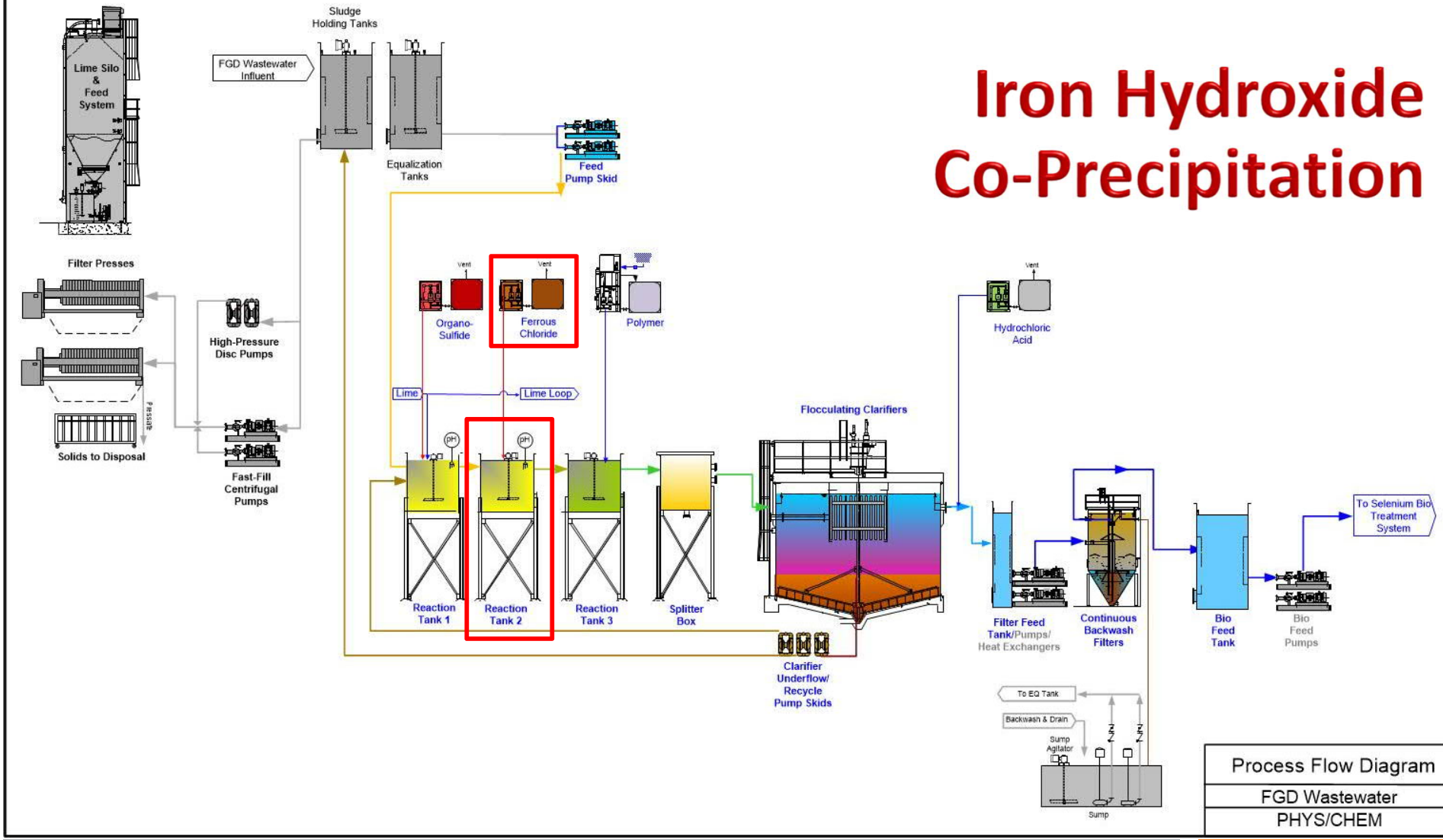


Influent Equalization

Dissolved Metals Reduction

TSS Reduction

Iron Hydroxide Co-Precipitation



Process Flow Diagram

FGD Wastewater

PHYS/CHEM

Iron Hydroxide Co-Precipitation

- Water consists primarily of negatively charged ions (anions).
- Adding ferrous chloride (FeCl2) salts allows for a high-positively charged ions (Fe2+ cations) to come into contact with anions, which lowers the distance between particles.
- “Pin flocs” are formed, which are agglomerations of these small particles.

Iron Hydroxide Co-Precipitation

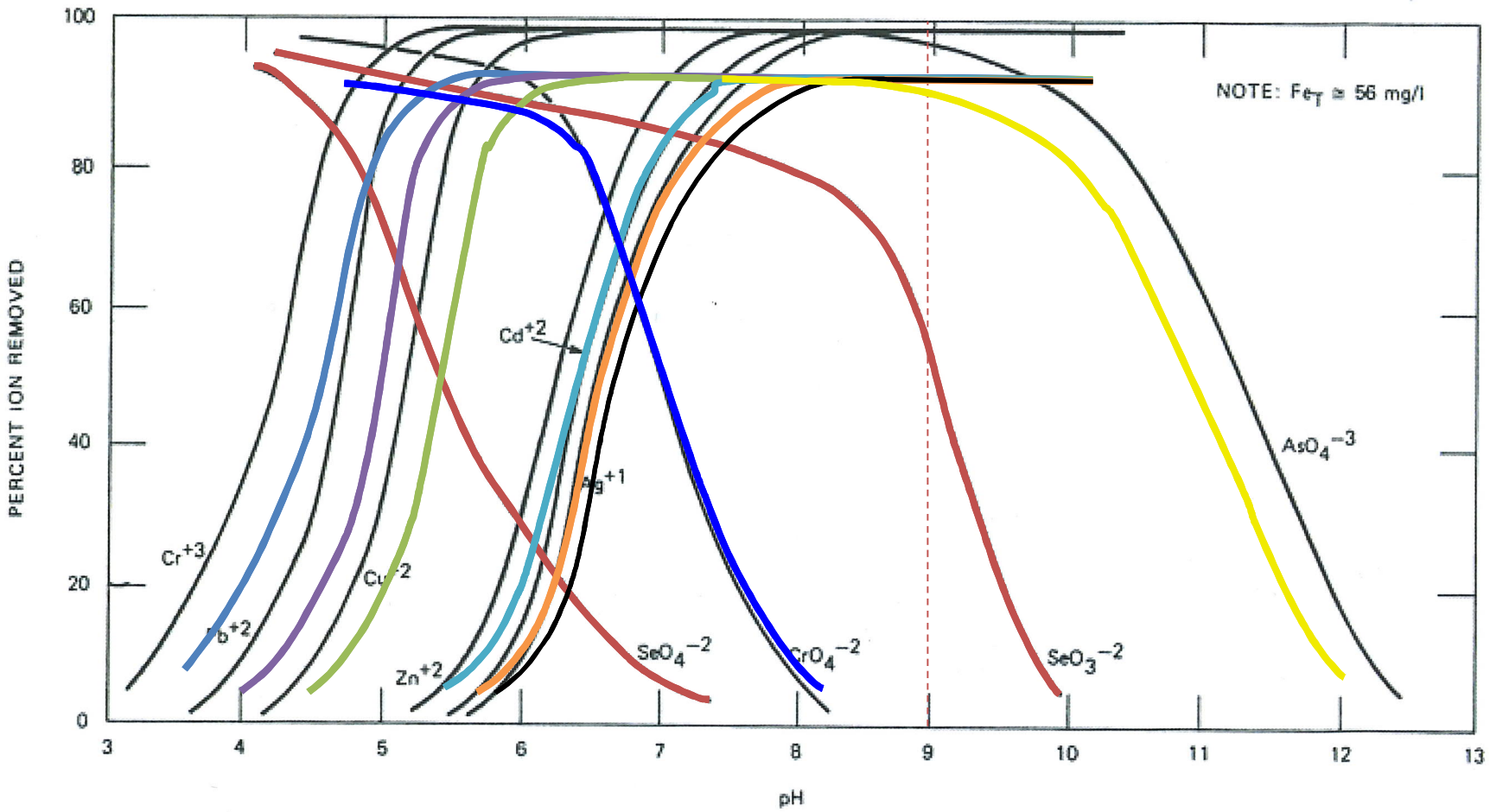


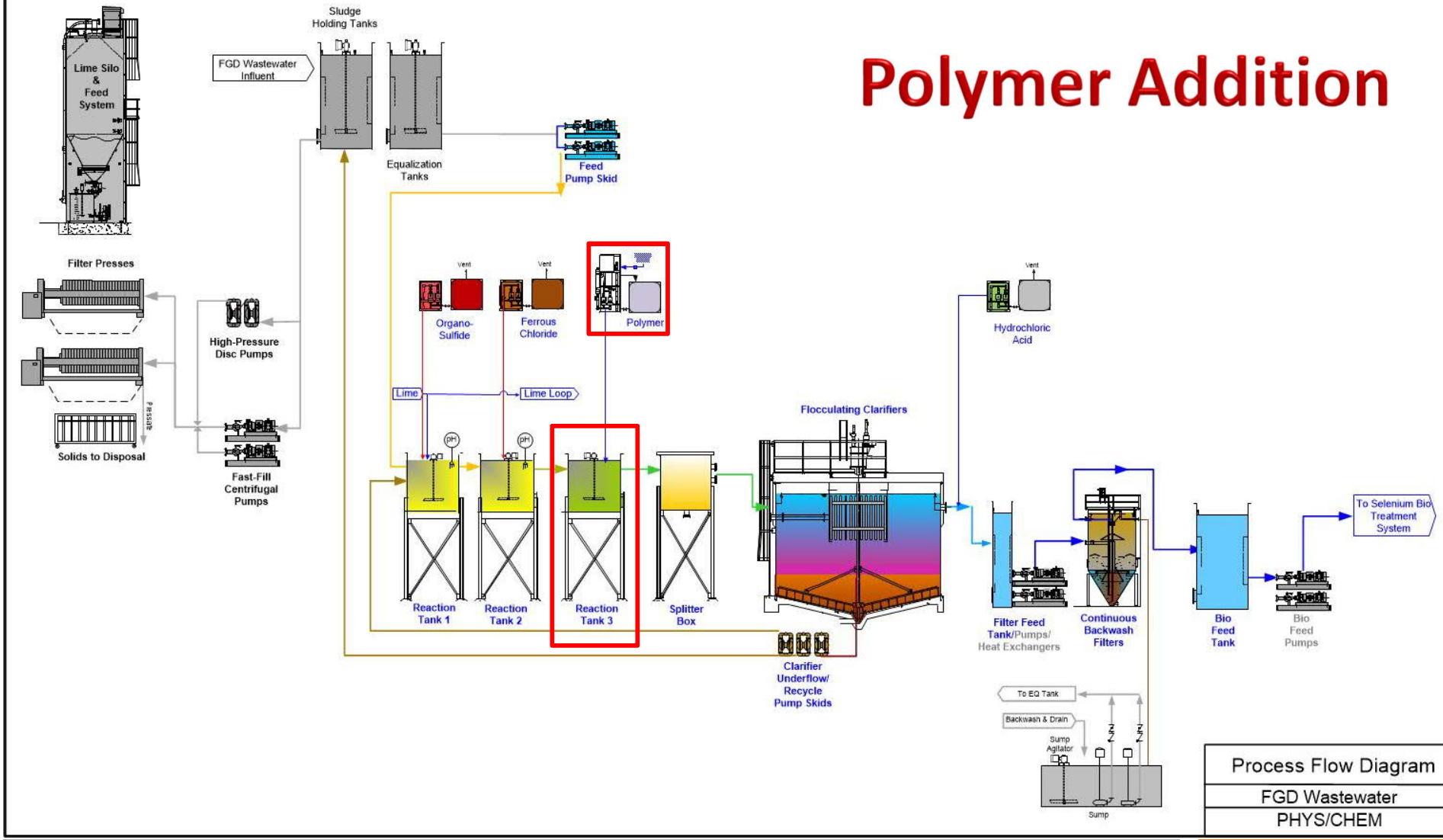
Figure 5-2
Trace element removal by $Fe(OH)_3$ precipitation/co-precipitation [5]

Influent Equalization

Dissolved Metals Reduction

TSS Reduction

Polymer Addition



Process Flow Diagram

FGD Wastewater

PHYS/CHEM

Solids Flocculation

- Pin flocs are still relatively small. Stokes Law shows that larger particles settle more quickly.
- Addition of a polymer helps increase the particle size and increase settling velocity.

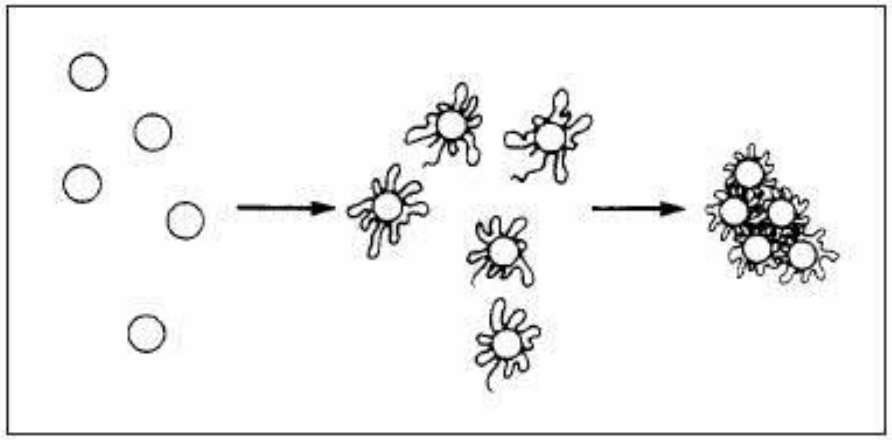
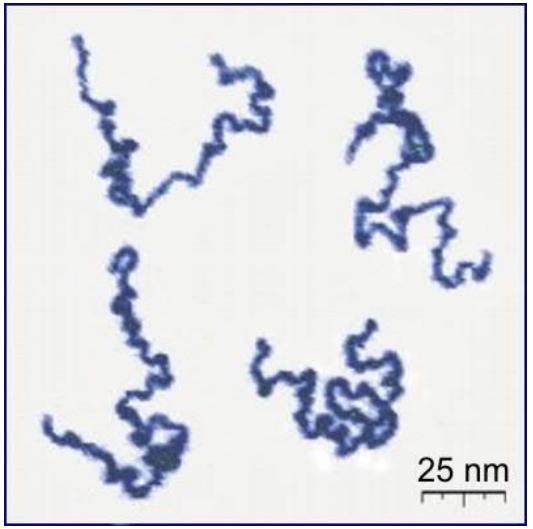
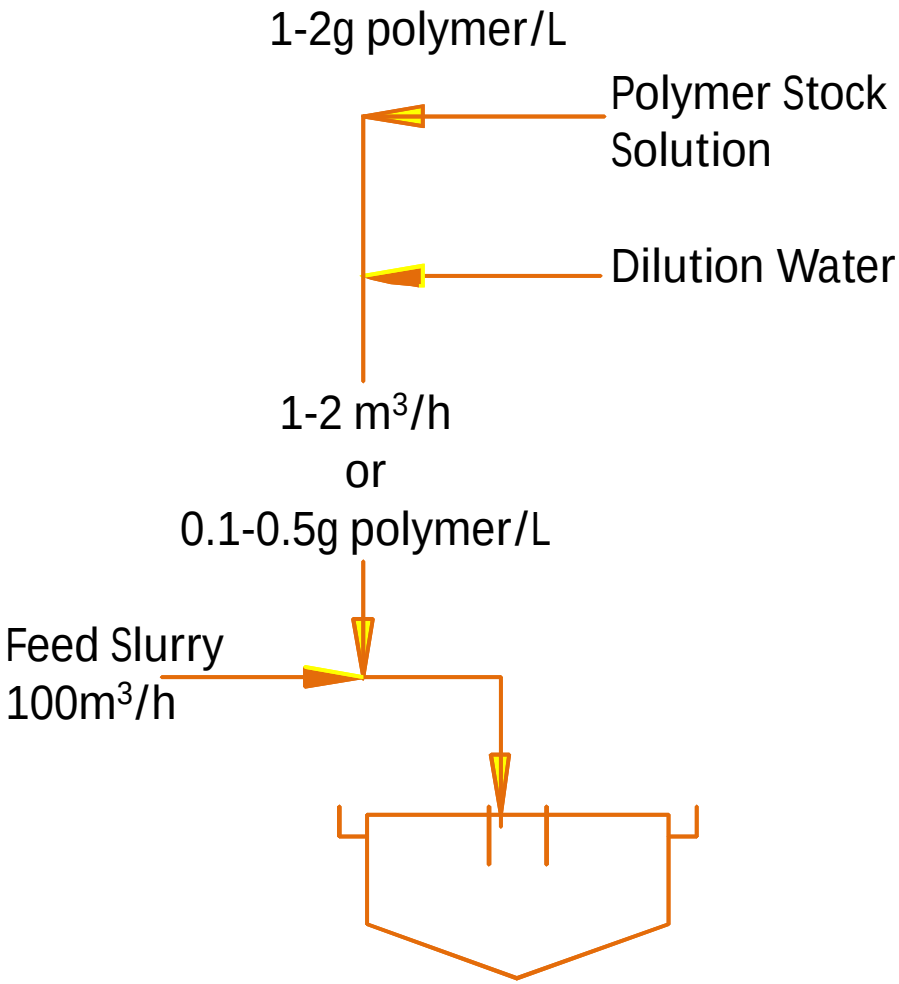


Figure 4 — *Polymer bridging*



Lessons Learned

Polymer Dilution



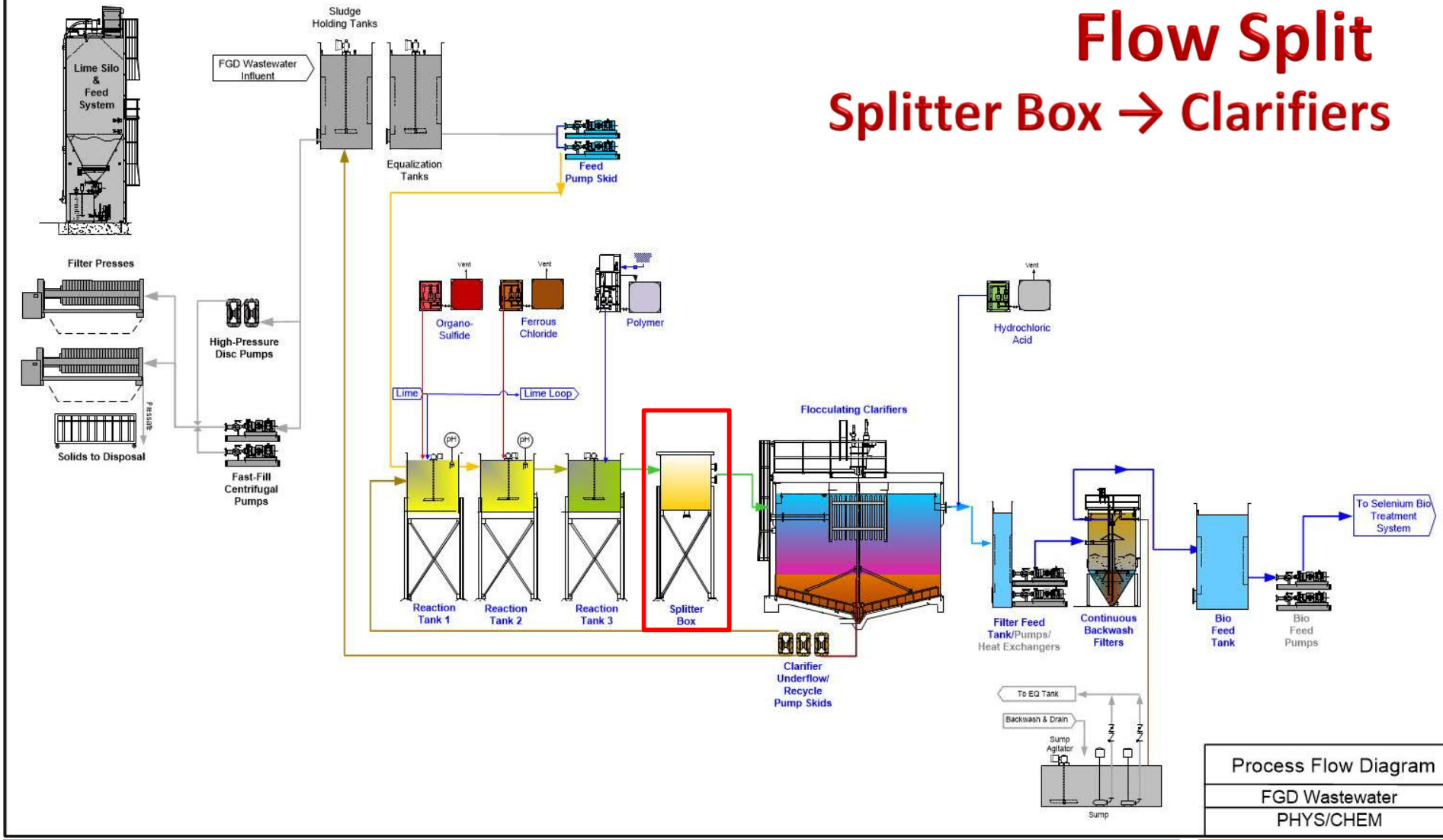
Influent Equalization

Dissolved Metals Reduction

TSS Reduction

Flow Split

Splitter Box → Clarifiers



Process Flow Diagram

FGD Wastewater

PHYS/CHEM

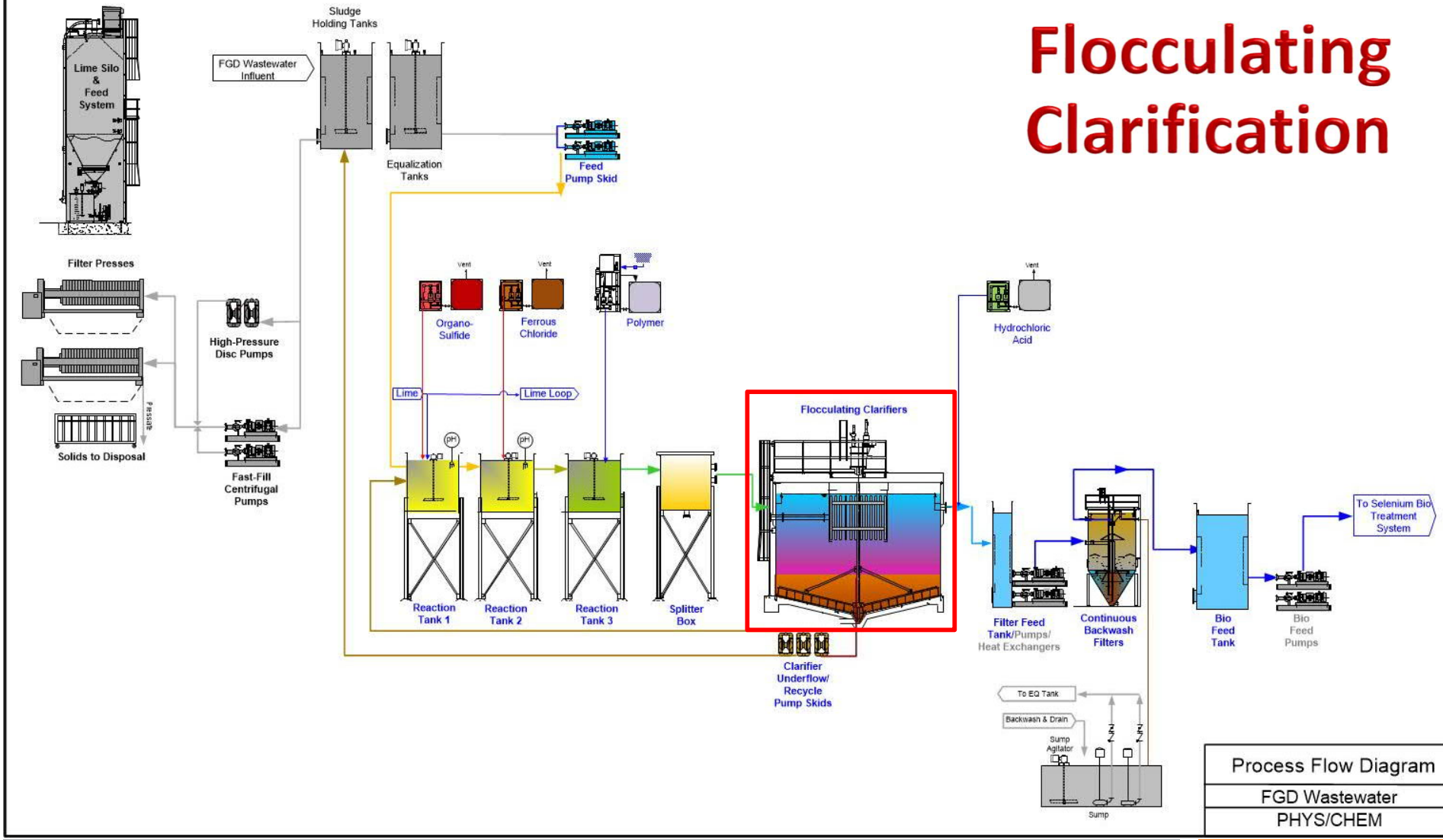
Splitter Box to Clarifiers

Influent Equalization

Dissolved Metals Reduction

TSS Reduction

Flocculating Clarification

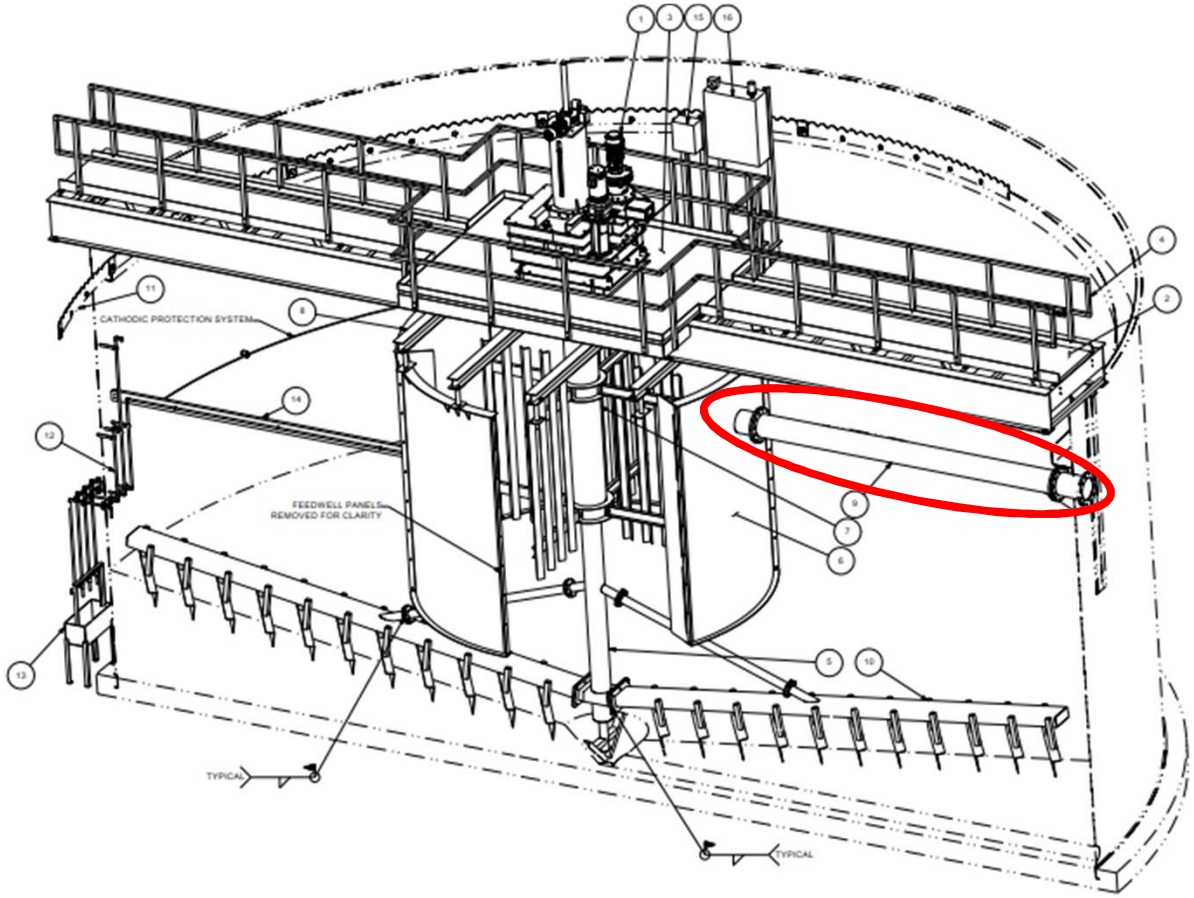


Process Flow Diagram

FGD Wastewater

PHYS/CHEM

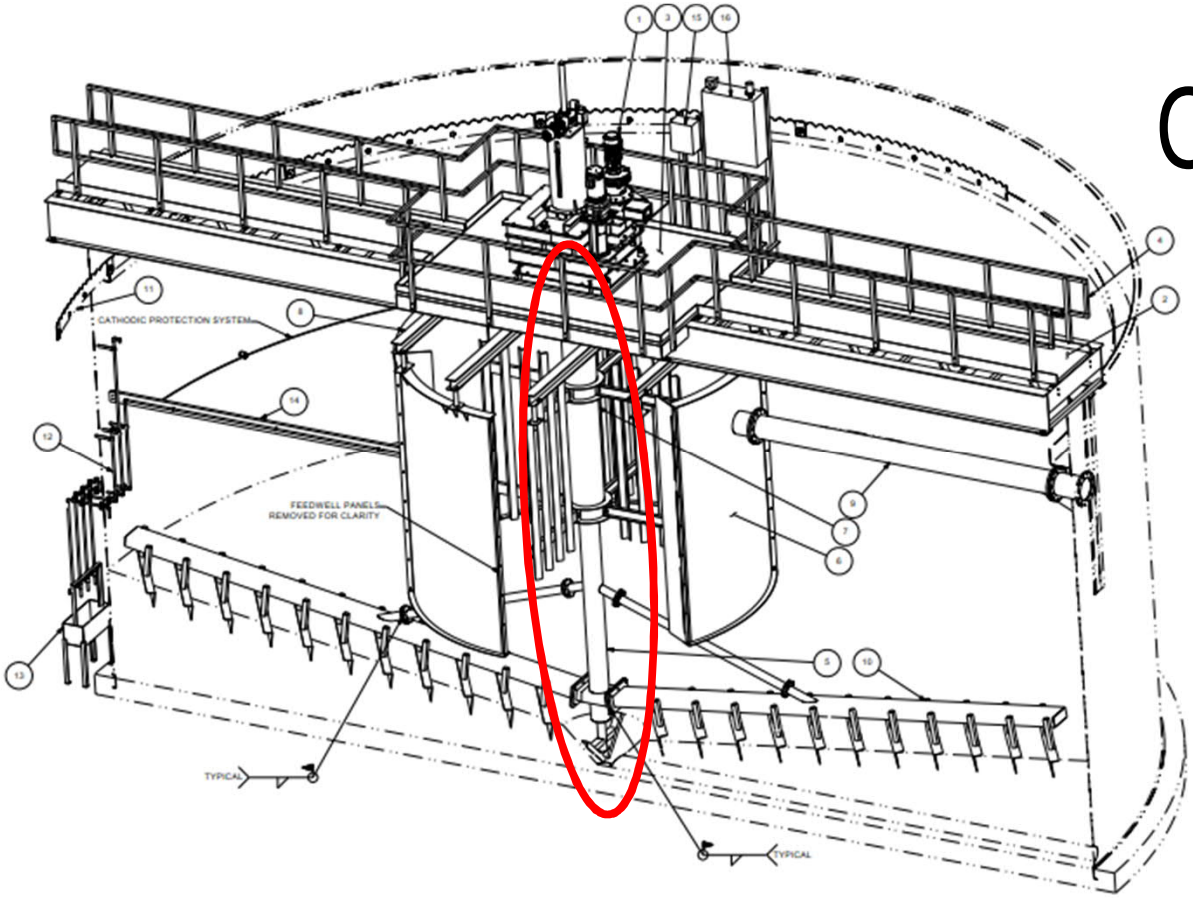
Flocculated Clarification



Feed Pipe

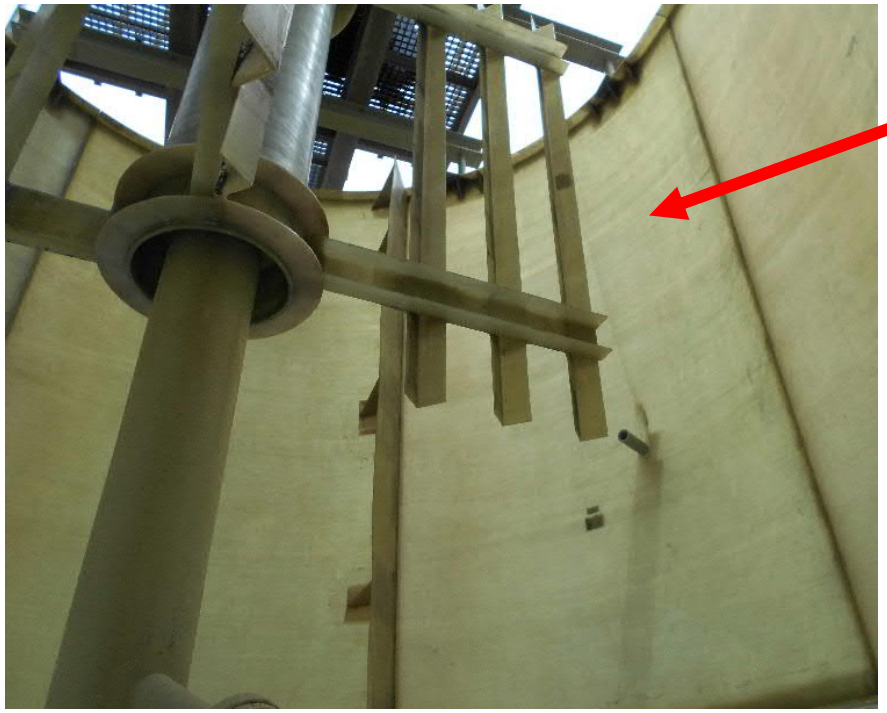
Feed Pipe

Flocculated Clarification

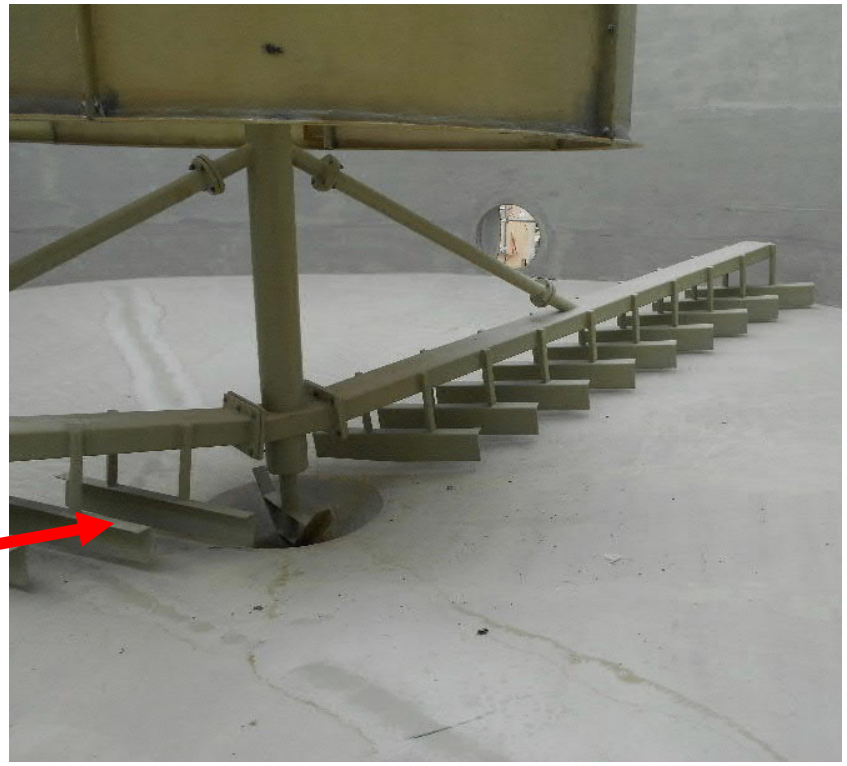


Center Shaft

Flocculated Clarification



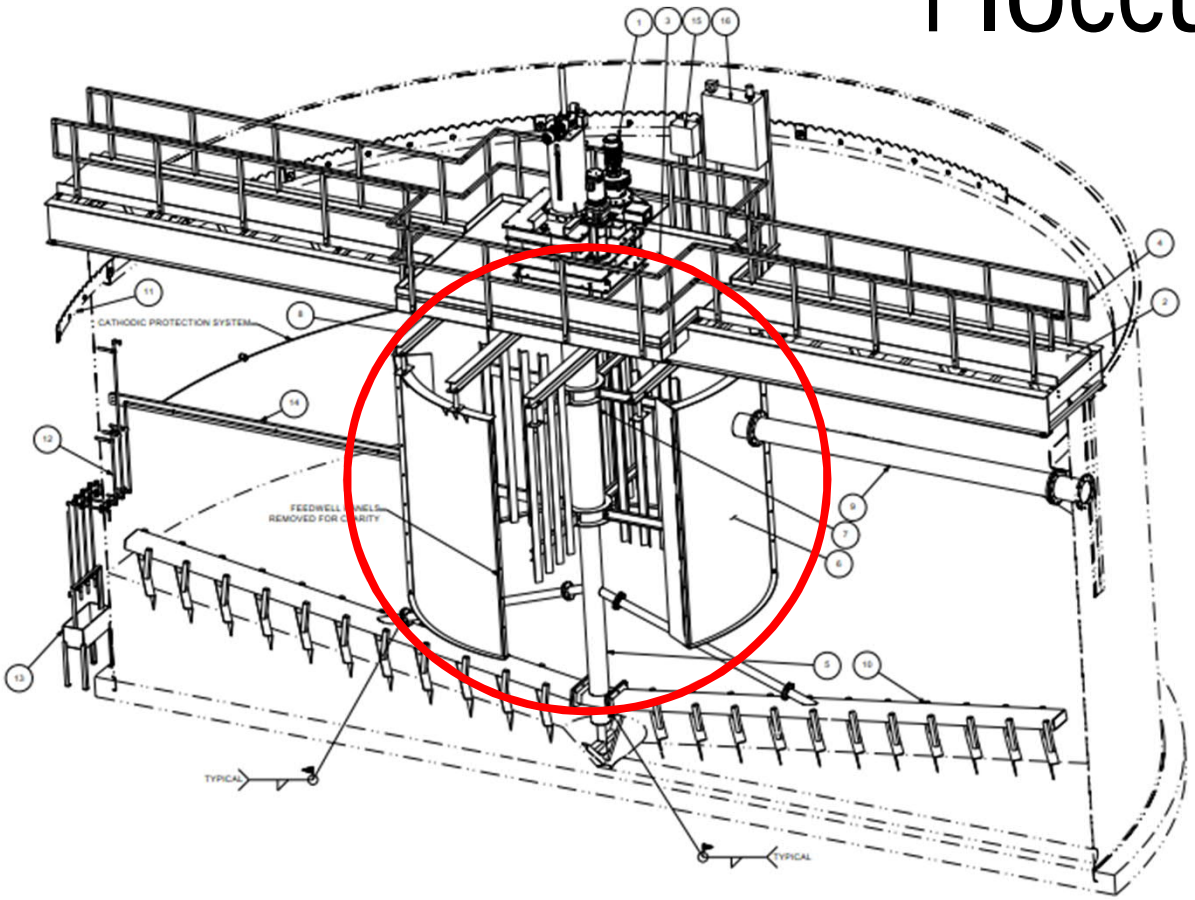
Impeller



Rakes

Flocculated Clarification

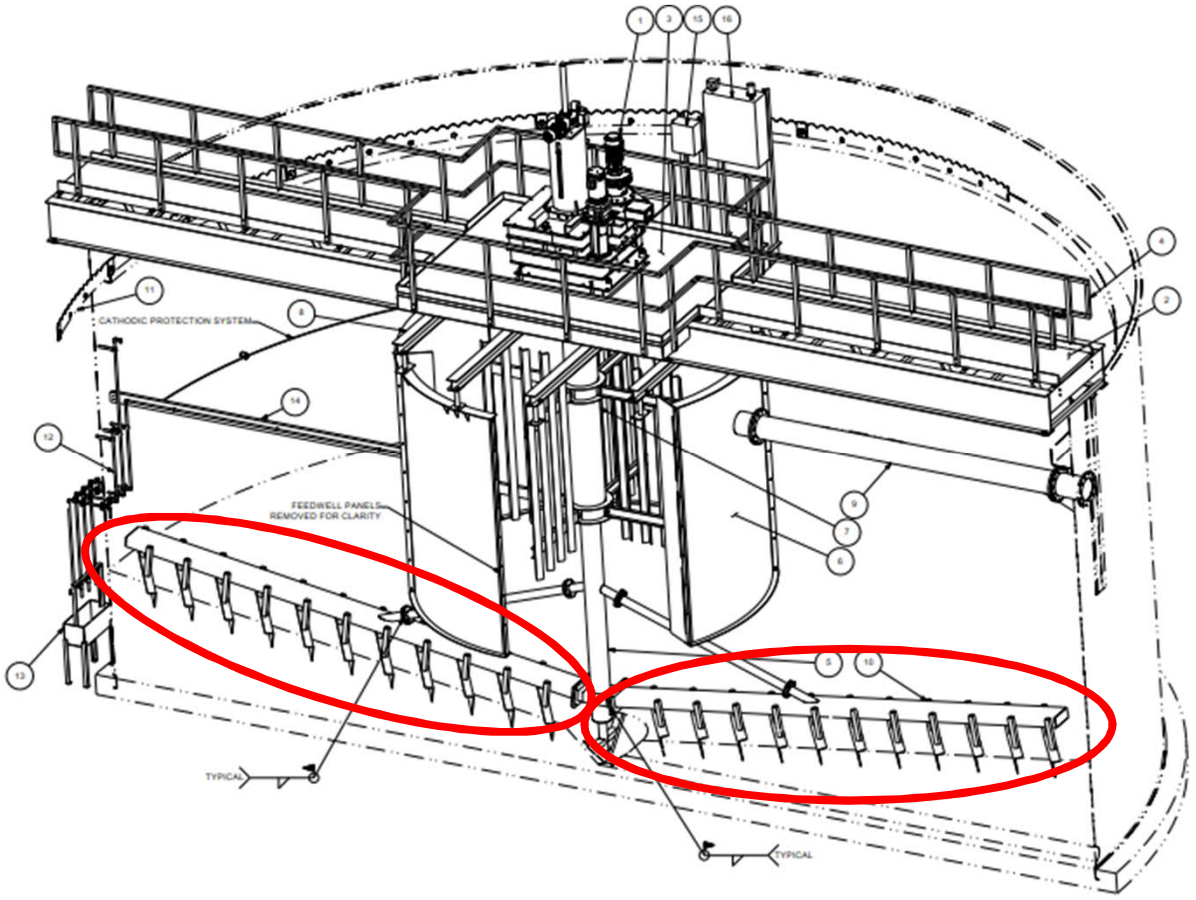
Flocculation Well



Flocculated Clarification

Flocculation Well

Flocculated Clarification



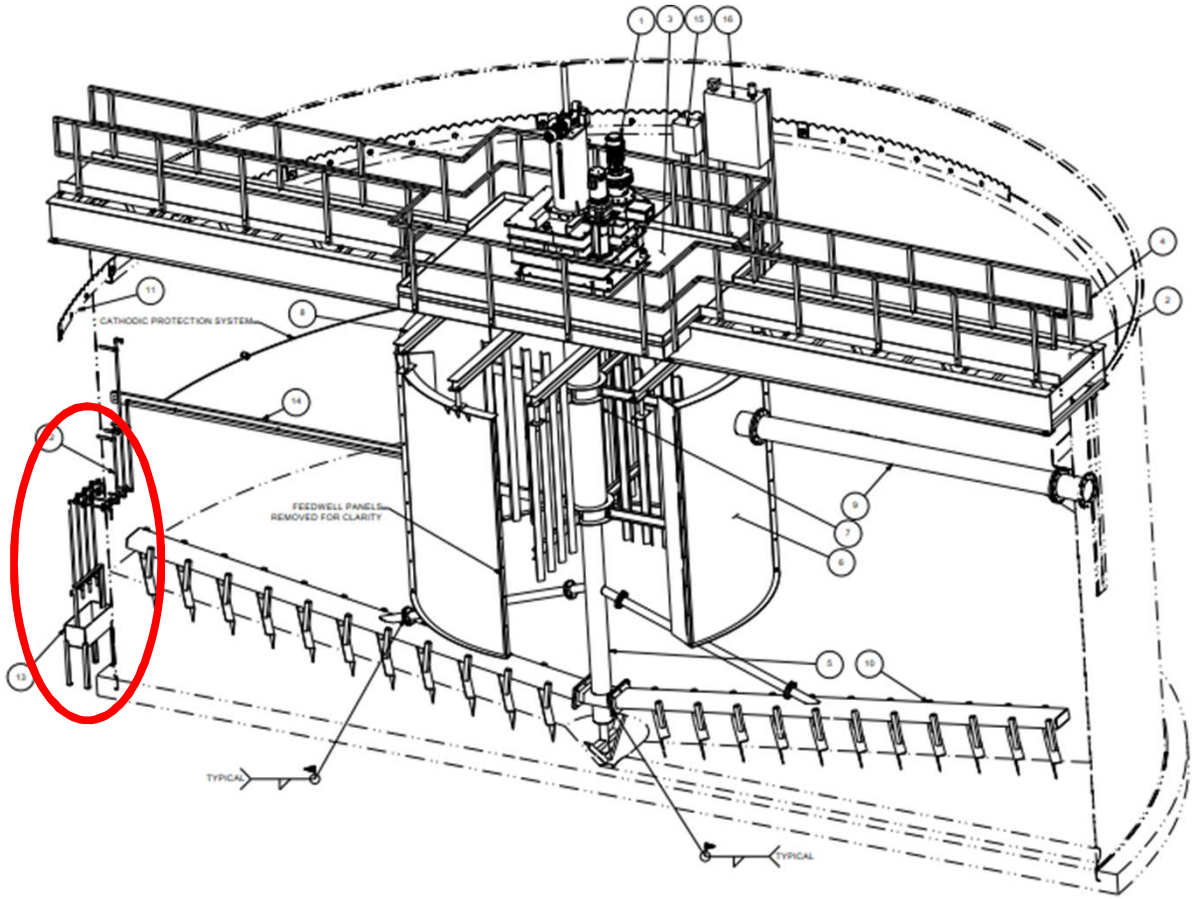
Segmented Rake Blades

Flocculated Clarification

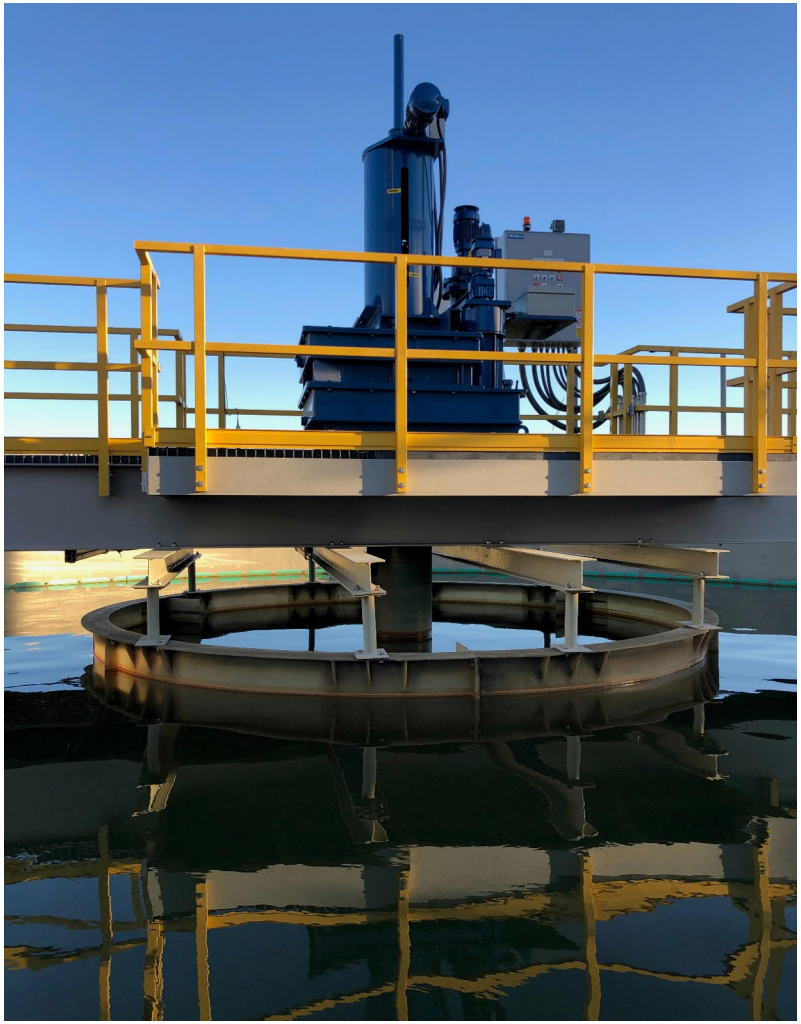
Segmented Rake Blades

Flocculated Clarification

Sample Sink/Lines



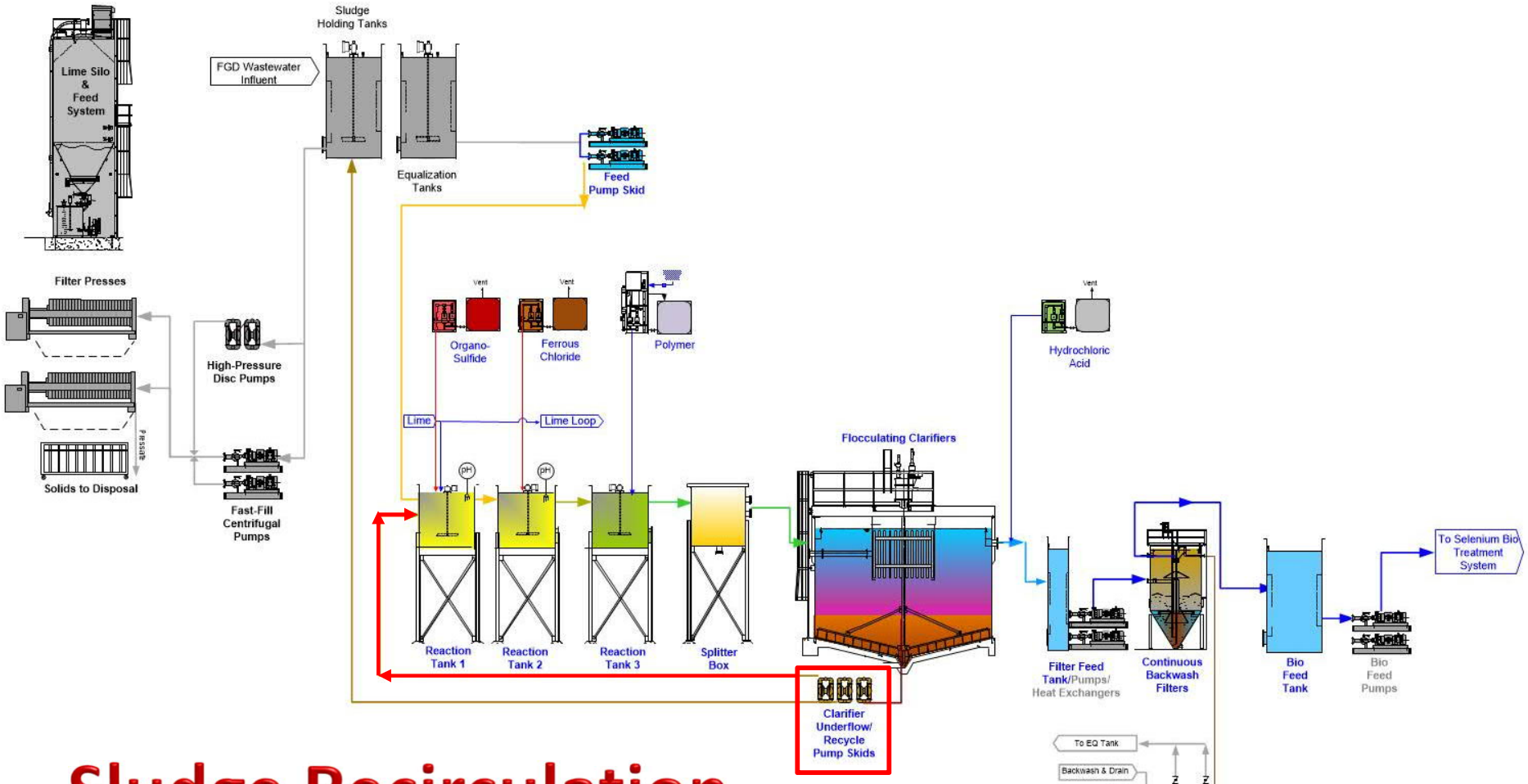
Flocculated Clarification



Influent Equalization

Dissolved Metals Reduction

TSS Reduction



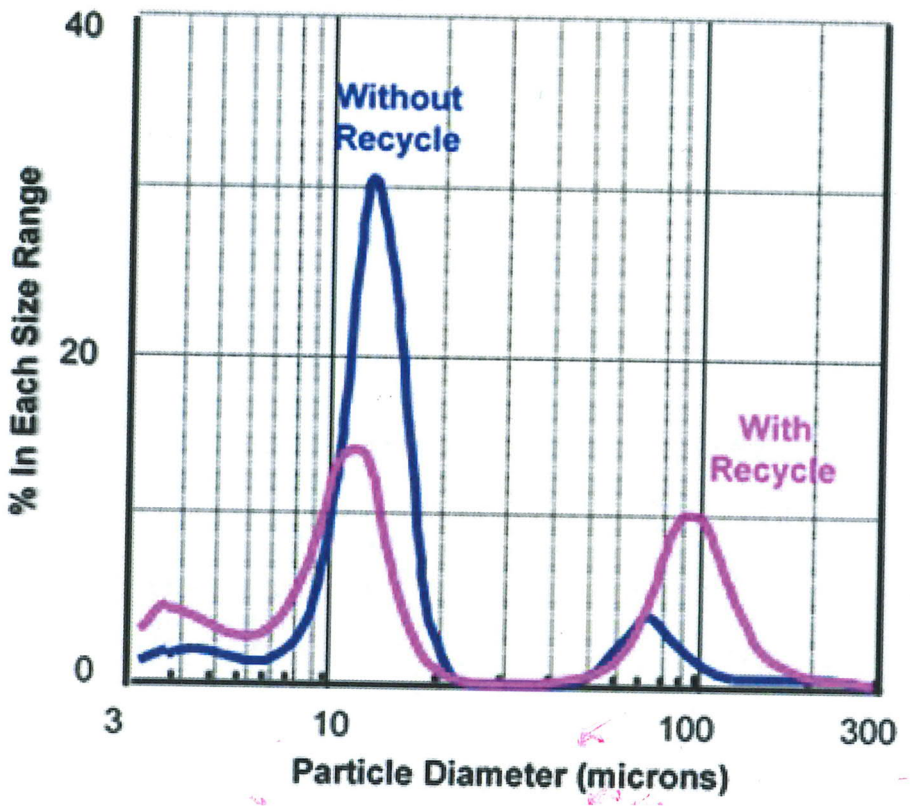
Sludge Recirculation

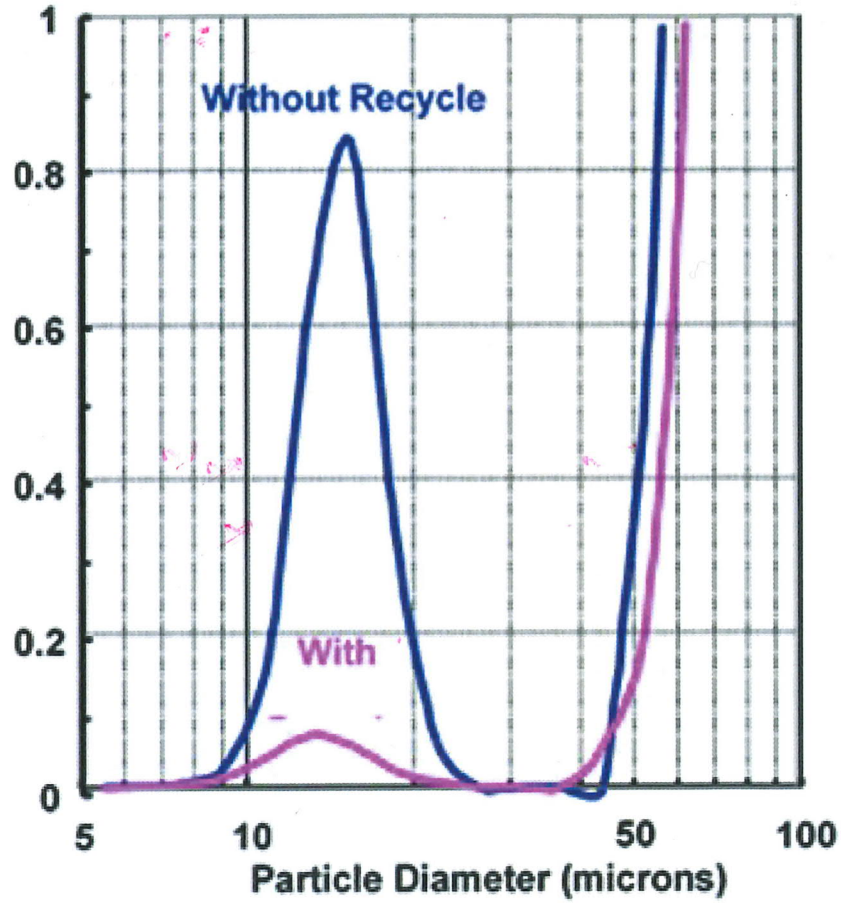
Process Flow Diagram

FGD Wastewater

PHYS/CHEM

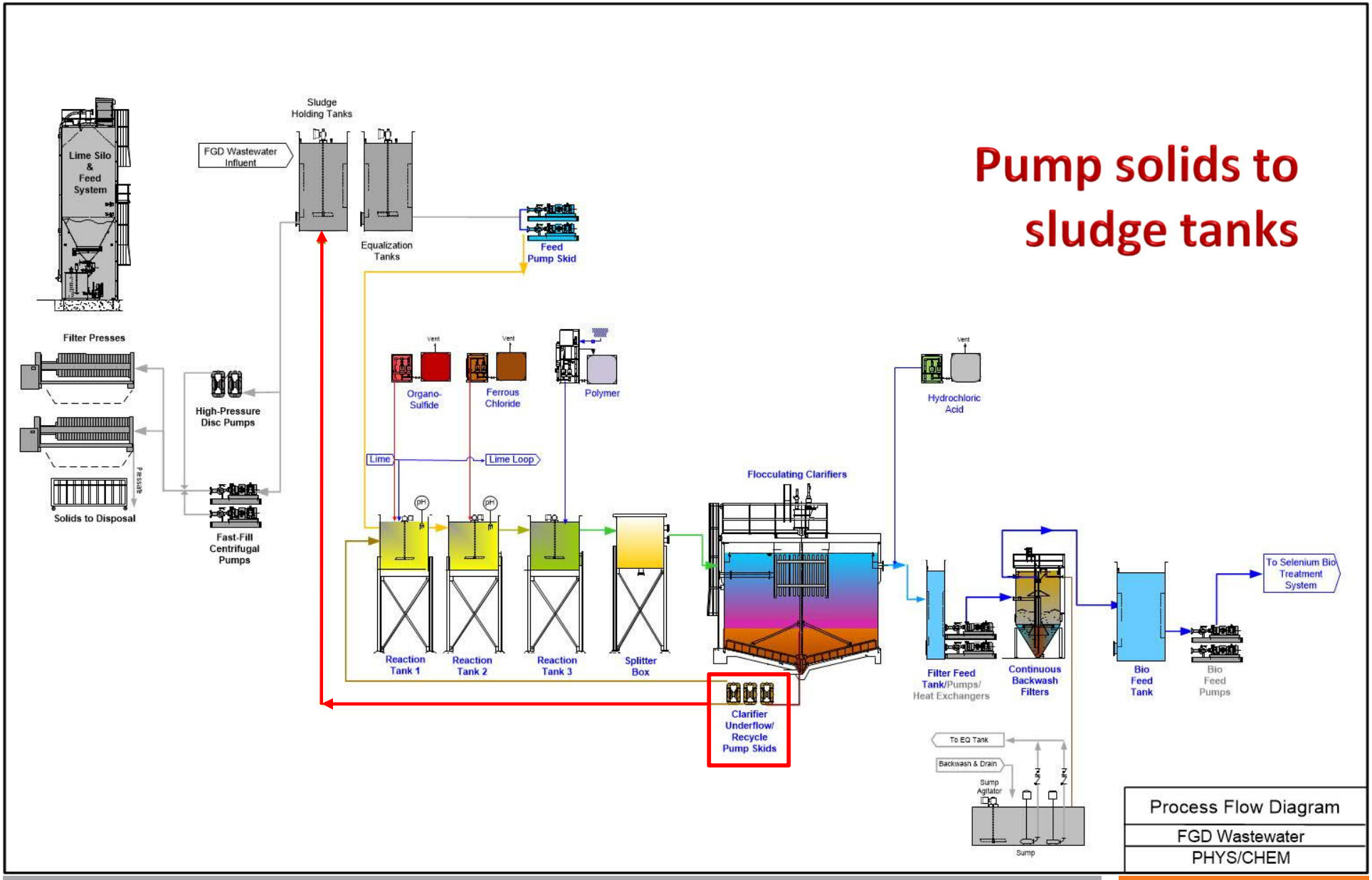
Sludge Recirculation Effects on Clarification





Clarifier Sludge Pumps

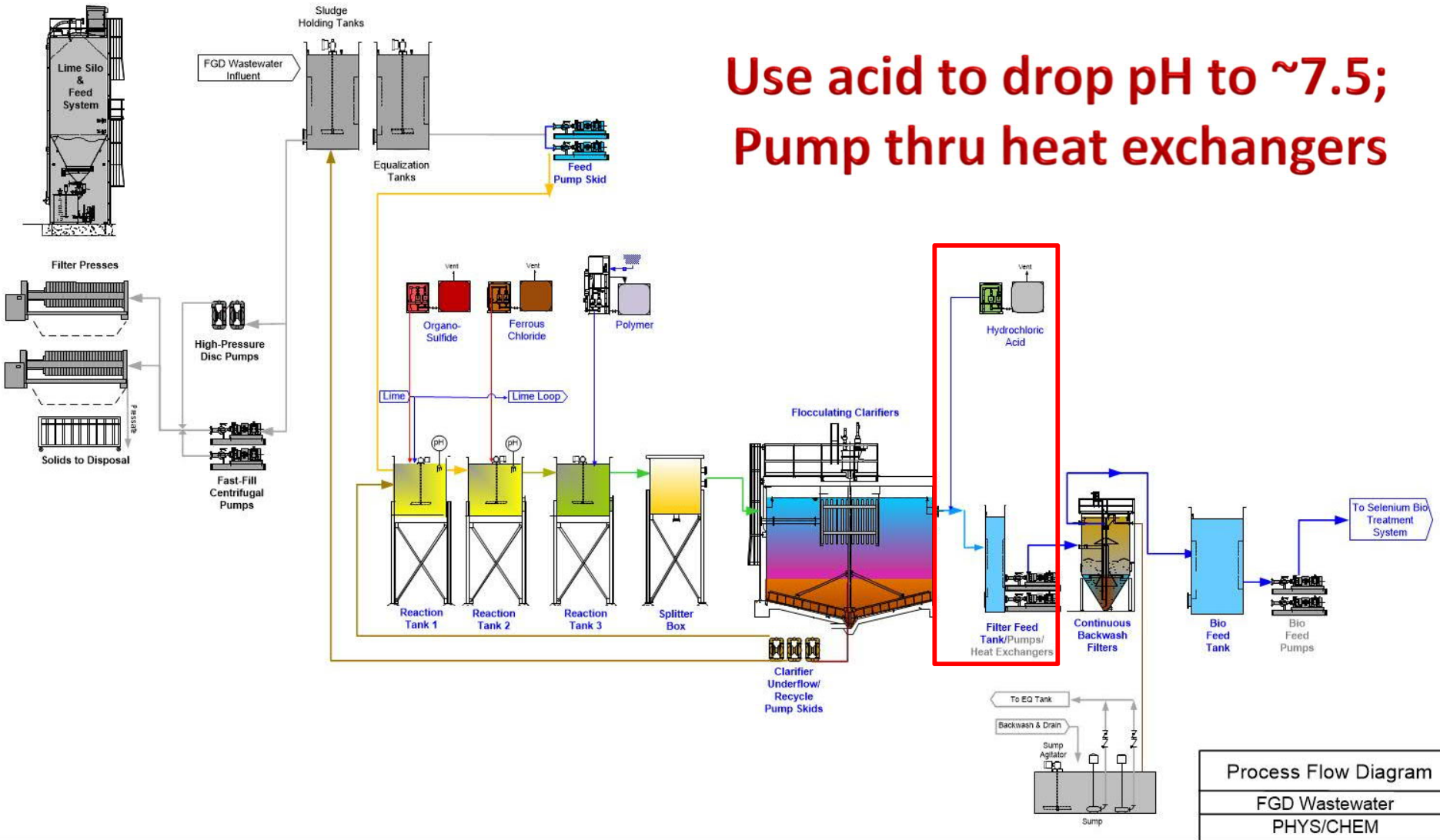
Sludge Dewatering



Pump solids to sludge tanks

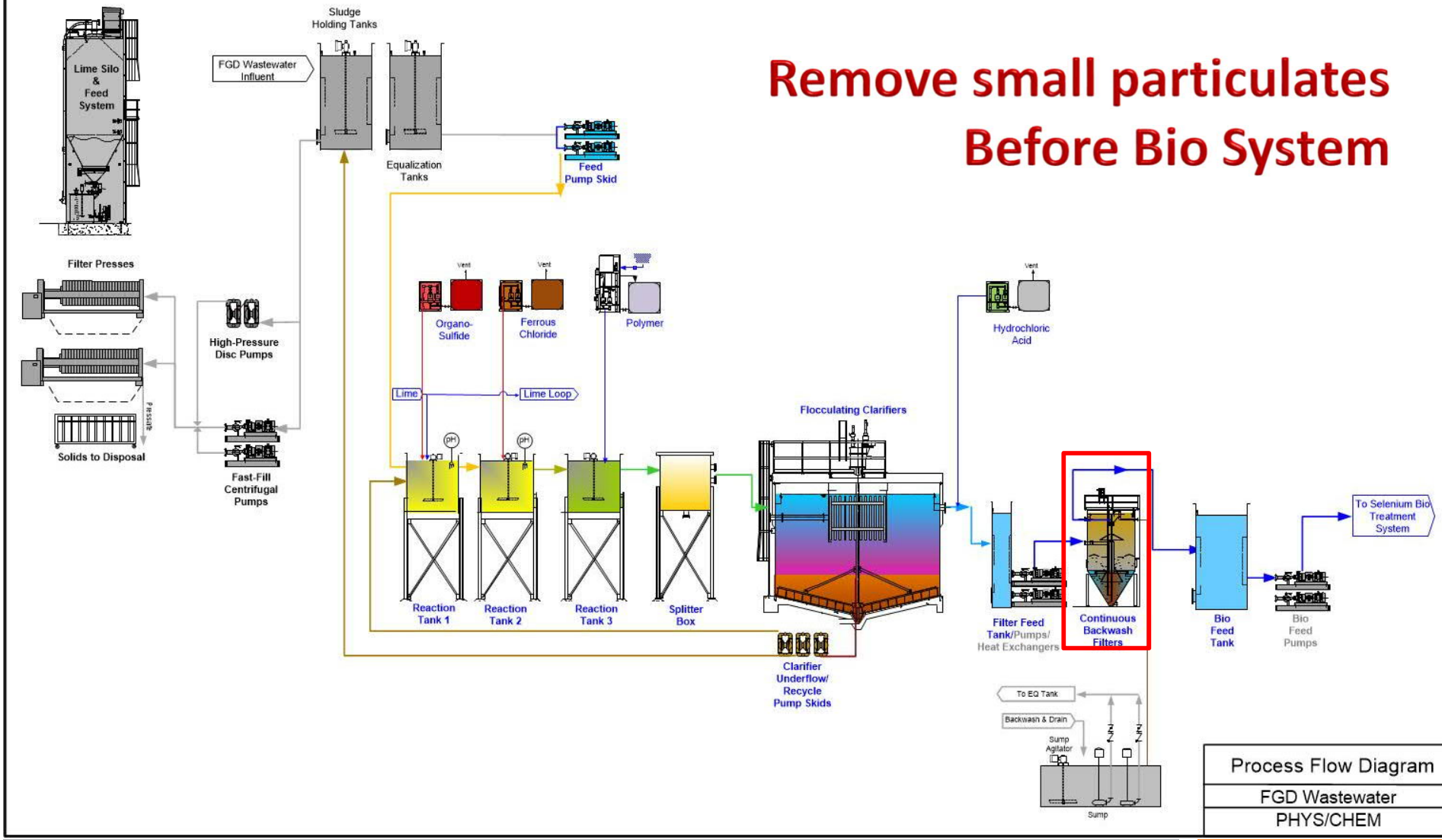
Drop pH & Temperature

Use acid to drop pH to ~7.5; Pump thru heat exchangers



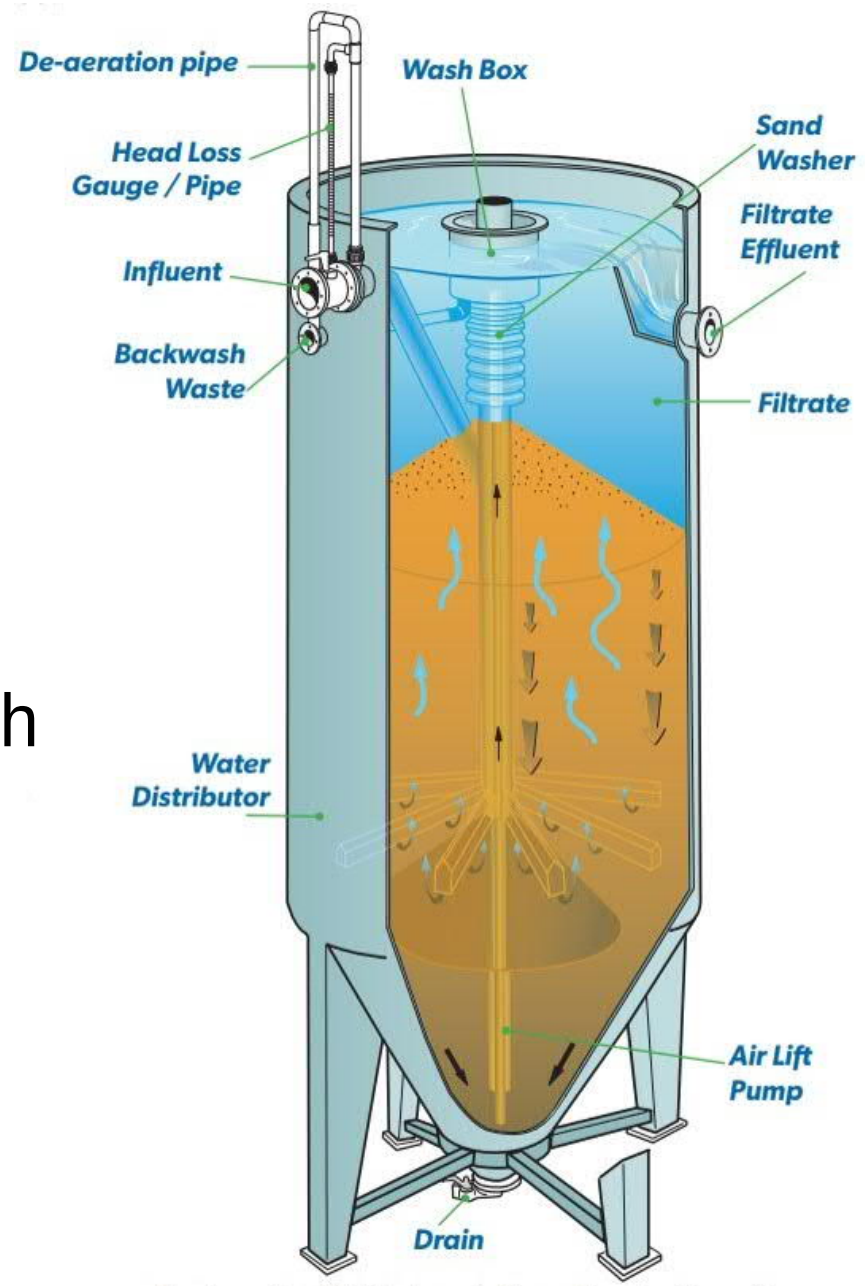
Sand Filters

Remove small particulates Before Bio System



Sand Filters

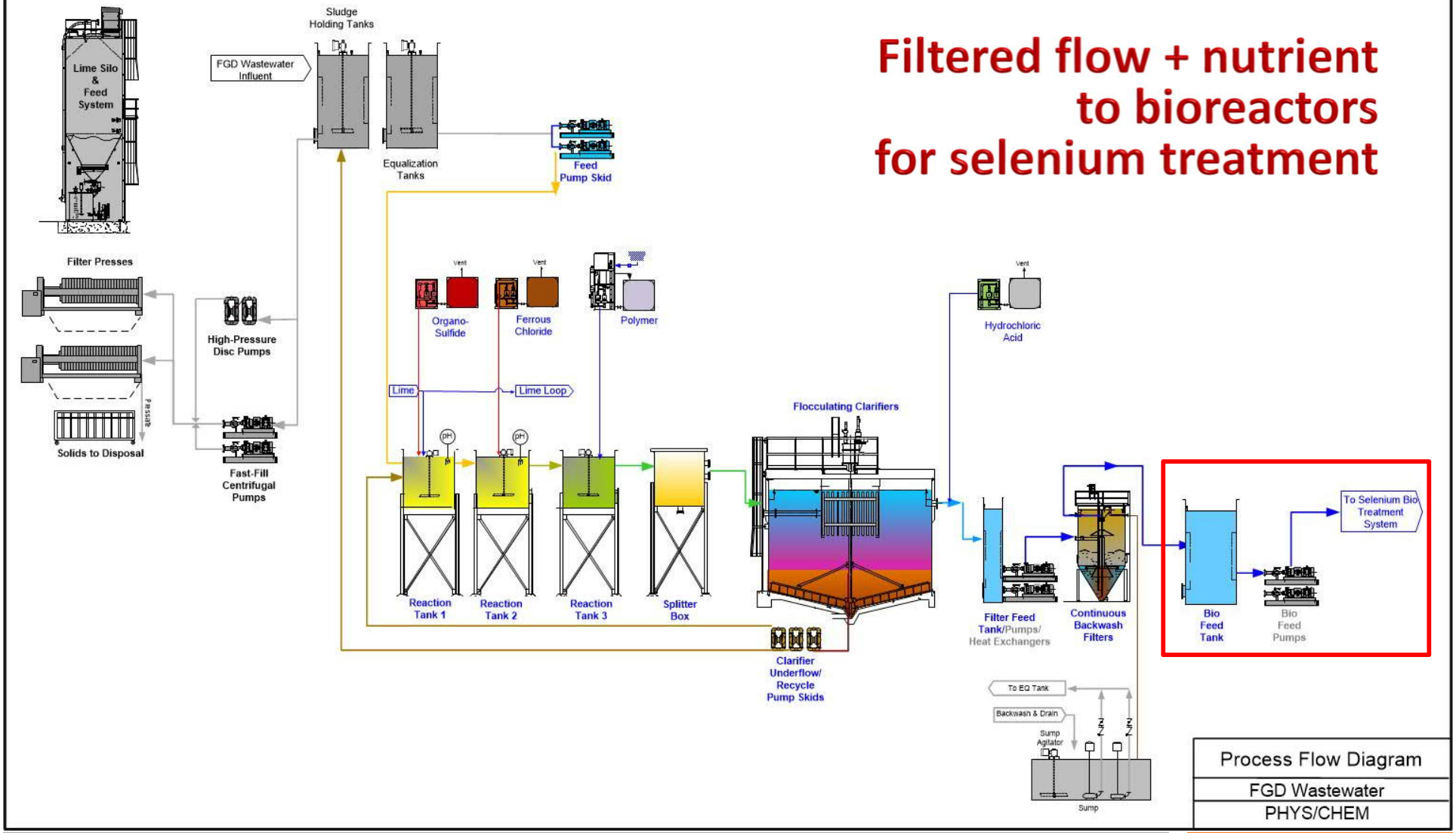
- Continuous-Backwash Sand Filters are typical
- FRP and HDPE construction
- No need for external backwash supply tanks and pumps
- Effective porosity ≈ 20 micron
- TSS < 5 mg/L



The SuperSand ™ Filter is available as a freestanding unit in multiple sizes. Tank materials of construction include Stainless Steel, FRP, and Carbon Steel.

Pump to Bio System

Filtered flow + nutrient to bioreactors for selenium treatment



Process Flow Diagram
FGD Wastewater
PHYS/CHEM

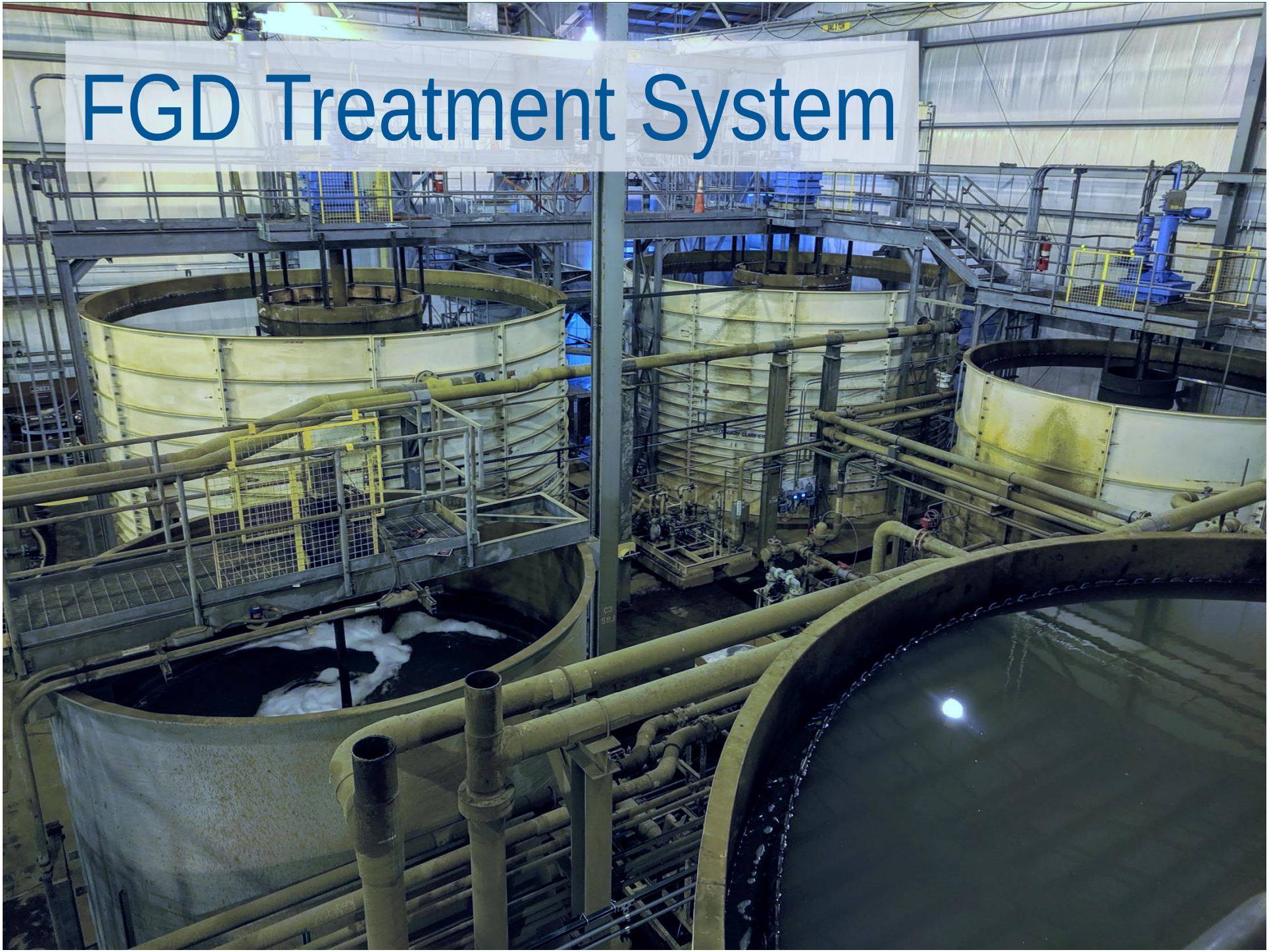
FGD Waste Water Treatment System

Overview – Ultrafiltration

Experience with FGD

WesTech

FGD Treatment System



FGD Treatment System

FGD Treatment System


FGD Treatment

Questions?

WesTech