REINHOLD ENVIRONMENTAL Ltd.

2010 APC Round Table
& Expo Presentation

July 18-20, 2010, in Concord, NC / Hosted by Duke Energy

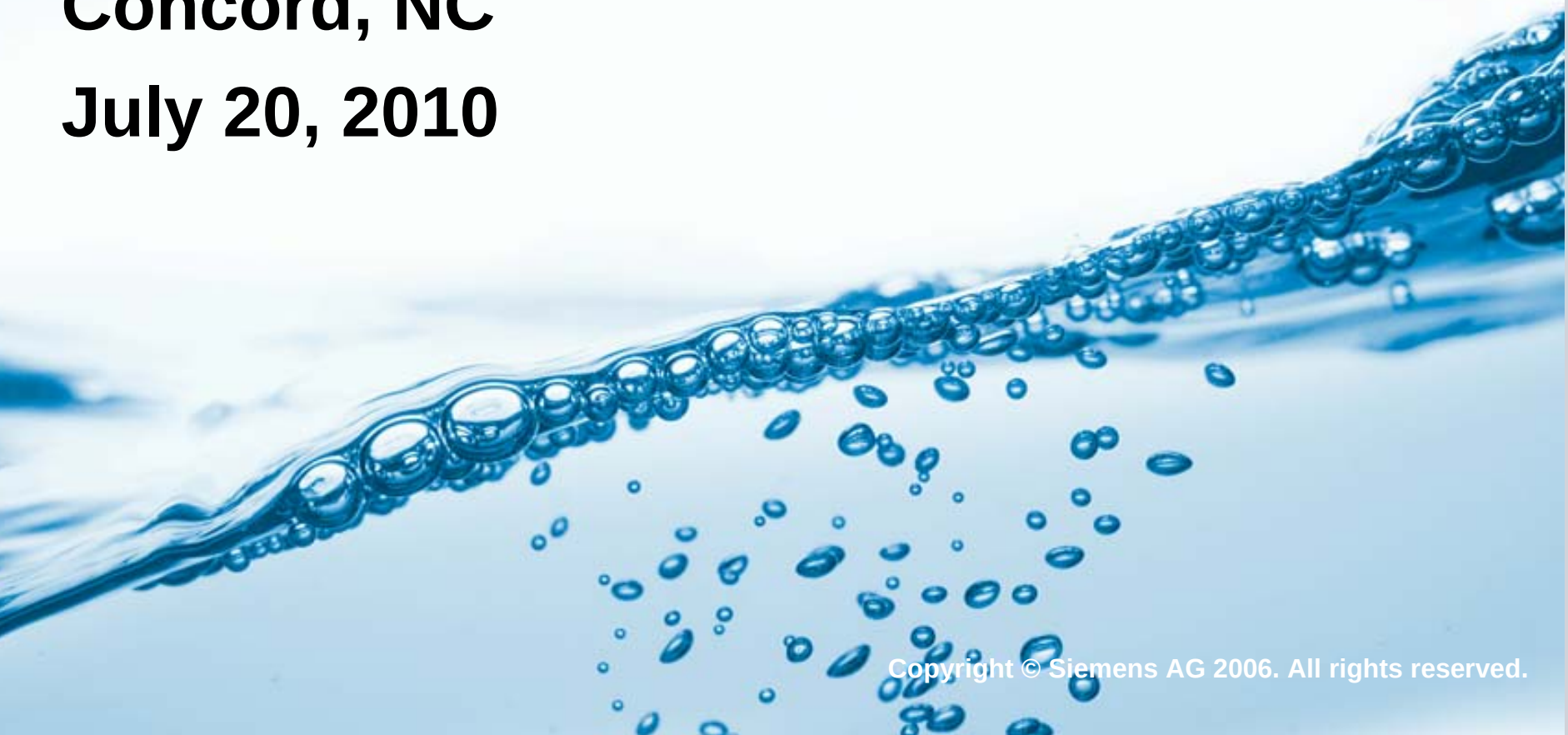
FGD Wastewater Treatment

SIEMENS

Presented at APC Round Table

Concord, NC

July 20, 2010



The Surge in FGD Implementation

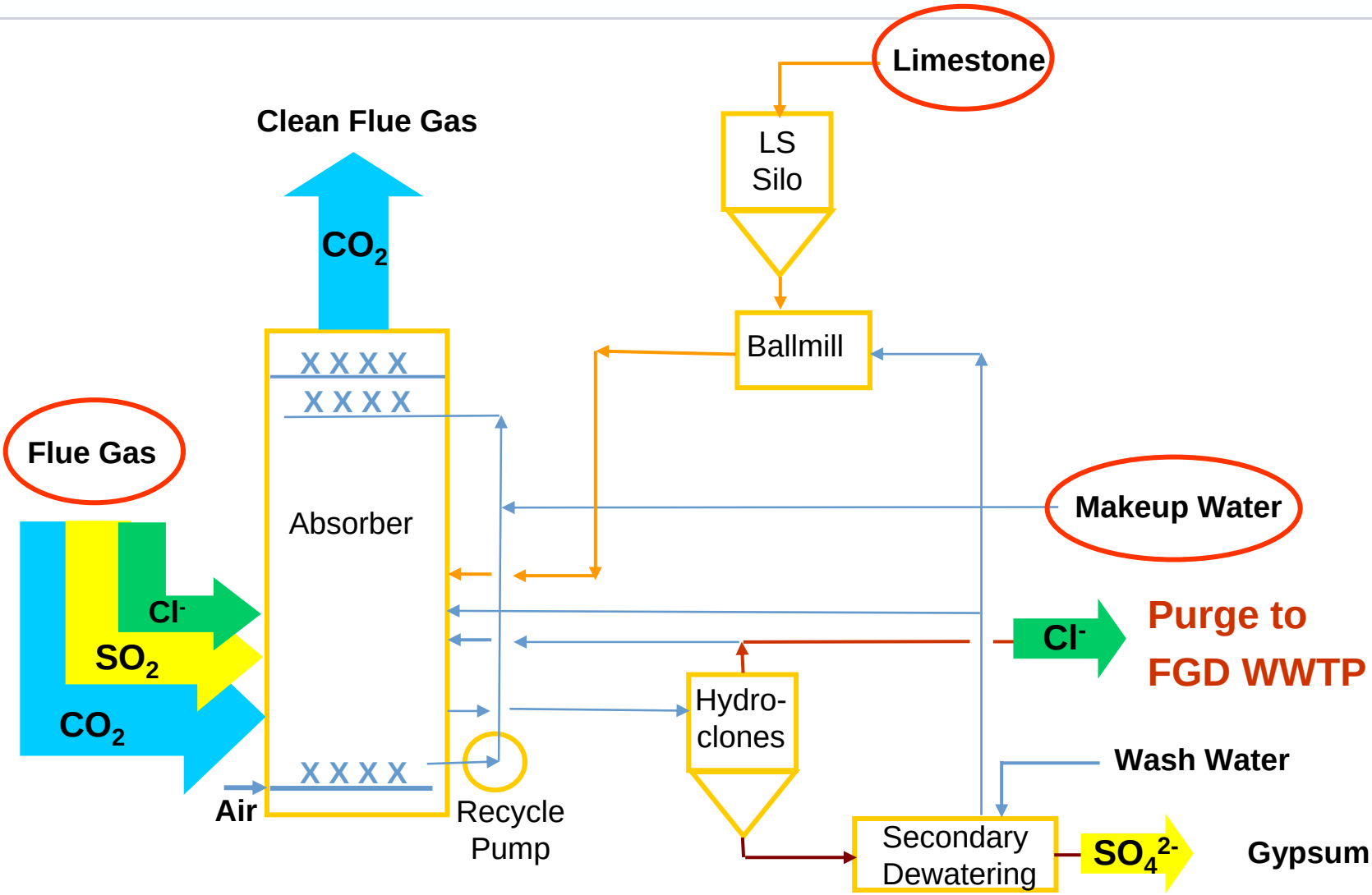
McIlvaine **2006** Report:

- US$168 billion FGD market in next 15 years
- 100,000 MW retrofits to meet U.S. Clean Air Interstate Rule (CAIR)
- 1,300,000 MW new & retrofits worldwide
- Predicted 2,200,000 MW of global coal-fired by 2020
- Predicted 65% would have FGD by 2020.
- Even emerging countries retrofitting: India, China, Viet Nam, etc.
- The global recession slowed everything, but still projects move ahead and may pick up pace again.

FGD Wastewater

- Frequently FGD system is wet limestone forced oxidation scrubber
- Capture of air contaminants end up in solids and liquid purge
- Solids purge might be suitable for sale of gypsum
- Liquid purge often requires treatment prior to discharge or may need to be zero liquid discharge in future

Simplified Limestone Forced Oxidation (LSFO) FGD Mass Balance



FGD Wastewater Flows

Wastewater flows depend on:

- Design Cl concentration in scrubber liquor
- Rated capacity of the boiler (MW)
- Removal of insoluble materials (fly ash, inerts)

Typically 0.1 to 0.3 gpm/MW

FGD Wastewater Characteristics

- Contains contaminants from coal, limestone, and makeup water
- High Suspended Solids (TSS)
- Elevated Heavy Metal concentrations
- pH 5.0 to 6.5
- Scale-forming: due to supersaturation with $CaSO_4$
- High salinity (TDS), with chloride level of 10,000 – 50,000 mg/l
- Varying levels of nitrates, nitrites, ammonia
- COD (500 – 1,000 mg/l) if DBA is used
- 45 to 55ºC
- Generally “Nasty WW”

Typical FGD Wastewater Treatment Requirements

Constituent	Typical Influent (mg/L)	Typical Effluent (mg/L)
TSS	**10,000 - 40,000**	**<15.0**
pH	4.5 - 6.0	6.5 - 8.5
As	0.05 - 3.0	<0.05
Cd	0.04 - 0.5	<0.10
Cr	0.3 - 5.0	<0.10
Cu	0.1 - 0.85	<0.10
Hg	**0.05 - 0.8**	**<0.002**
Ni	0.2 - 6.0	<0.05
Pb	0.1 - 3.0	<0.05
Se	**0.2 - 4.0**	**0.1 – 4.0**
Zn	0.4 - 8.0	<0.10
Cl	10,000 - 50,000	10,000 - 50,000
SO_4	1,500 - 8,000	800 - 2,500
Ca	1,000 - 20,000	5,000 - 25,000
N	**50-200**	**4-10**

Key Design Considerations for Wastewater System

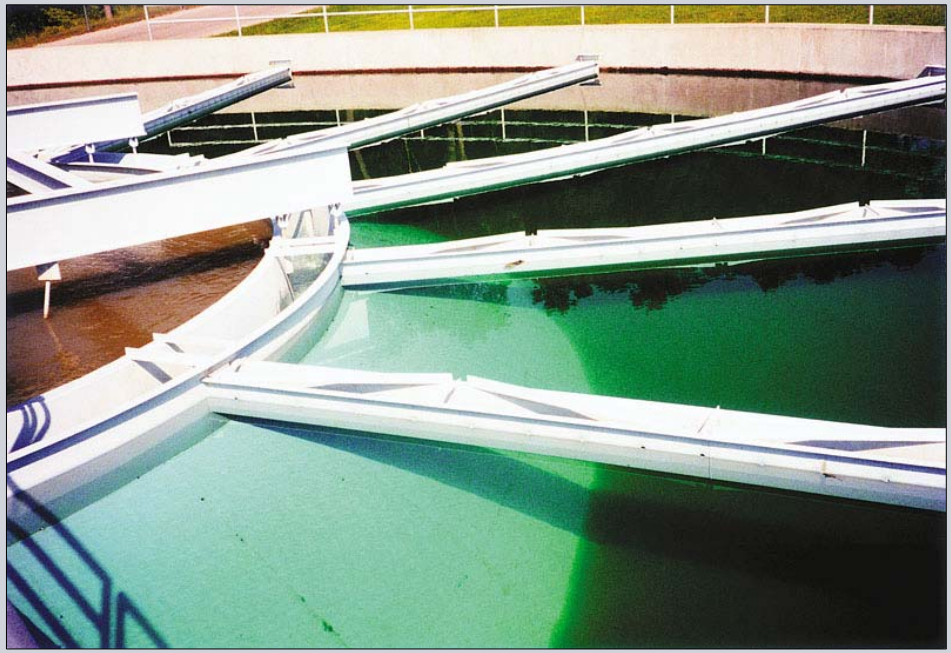
- Influent Composition
- Discharge Requirements
- Solids Handling
- Materials of Construction
- Unique Owner's Requirements

Major Cost Drivers

- Flow
- Solids Load
- Specific discharge requirements for Se, BOD, Nitrogen, etc.

Physical-Chemical Treatment

- Lowers scaling potential
- Removes heavy metals
- Removes TSS
- Requires application of specific reaction vessels, clarifier, thickener, filter and dewatering designs



Chemistry Basics

FGD System

$SO_2 + CaCO_3 \Rightarrow CaSO_3 + CO_2$

$CaSO_3 + ½O_2 + 2H_2O \Rightarrow CaSO_4.2H_2O$

Wastewater Treatment System (WWTS) - Heavy Metal Precipitation

$Zn^{2+} + 2OH\text{-} \Rightarrow Zn(OH)_2$

$Zn^{2+} + S^{2-} \Rightarrow ZnS$

Zn^{2+} + ‘OS’ => Zn’OS’

WWTS - Selenium Reduction

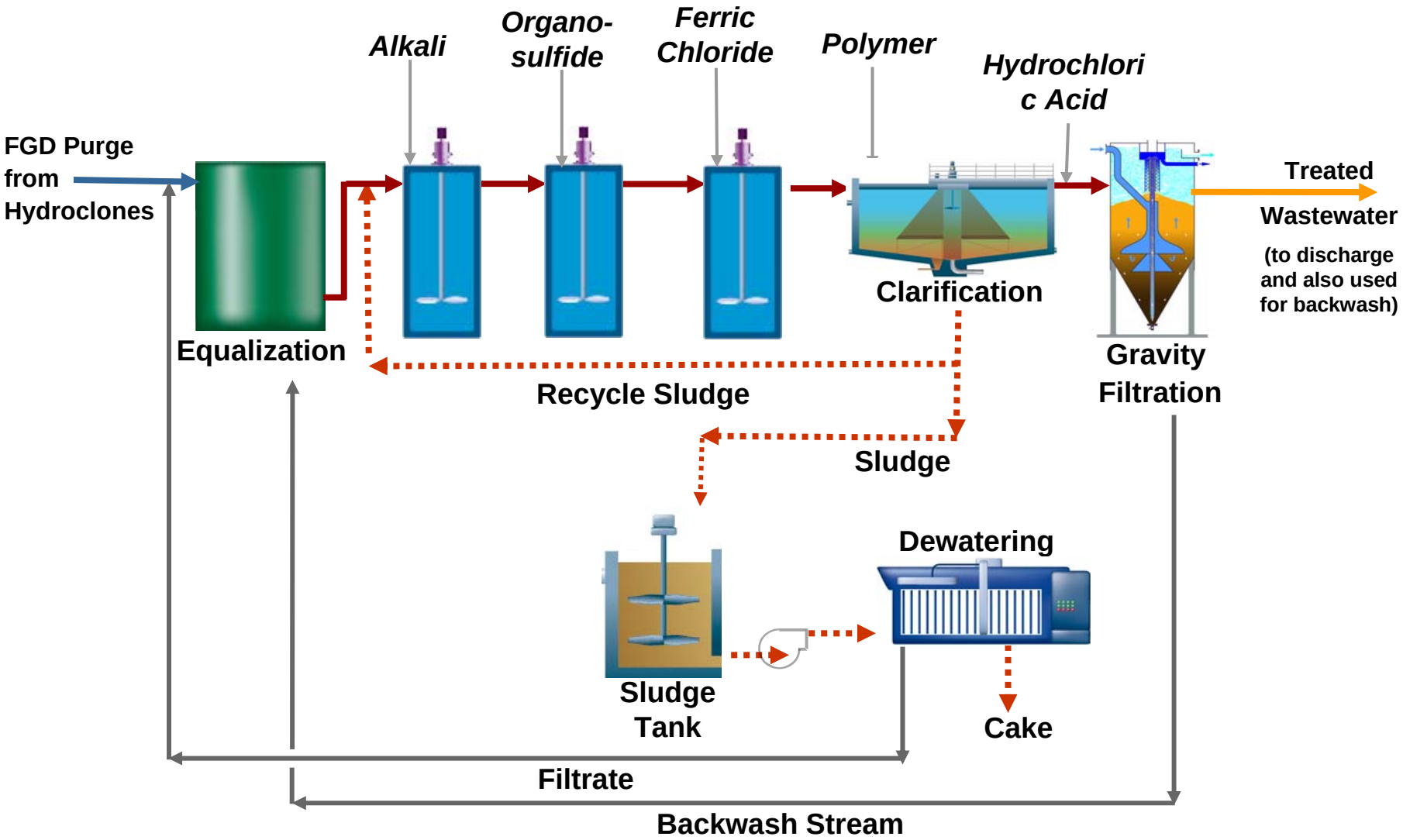
SeO_3^{2-}

SeO_4^{2-} + electron donor + bacteria => Se(0) + CO_2

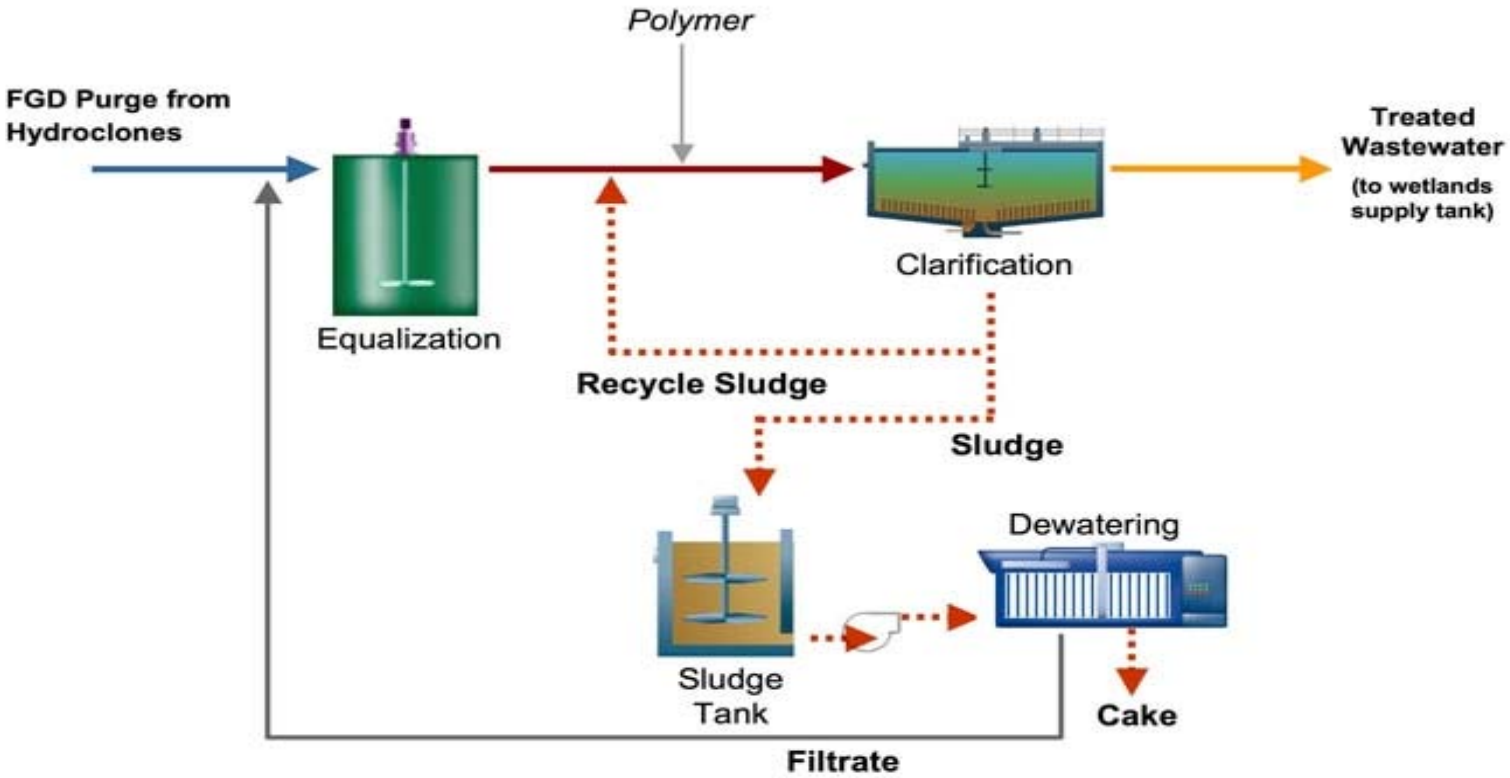
Denitrification

NO_3^- + electron donor + bacteria => NO_2^- => N_2 + CO_2

Physical Chemical FGD Wastewater Treatment System



Marshall Station WWTS PFD



Marshall Station

Marshall **Station** Wastewater Treatment System

Marshall FGD WWTS - Clarification

High Pressure Pumps feeding Dewatering Unit

Recess Chamber Filter Presses

Filter Press Discharge

Allen Station FGD WWTS

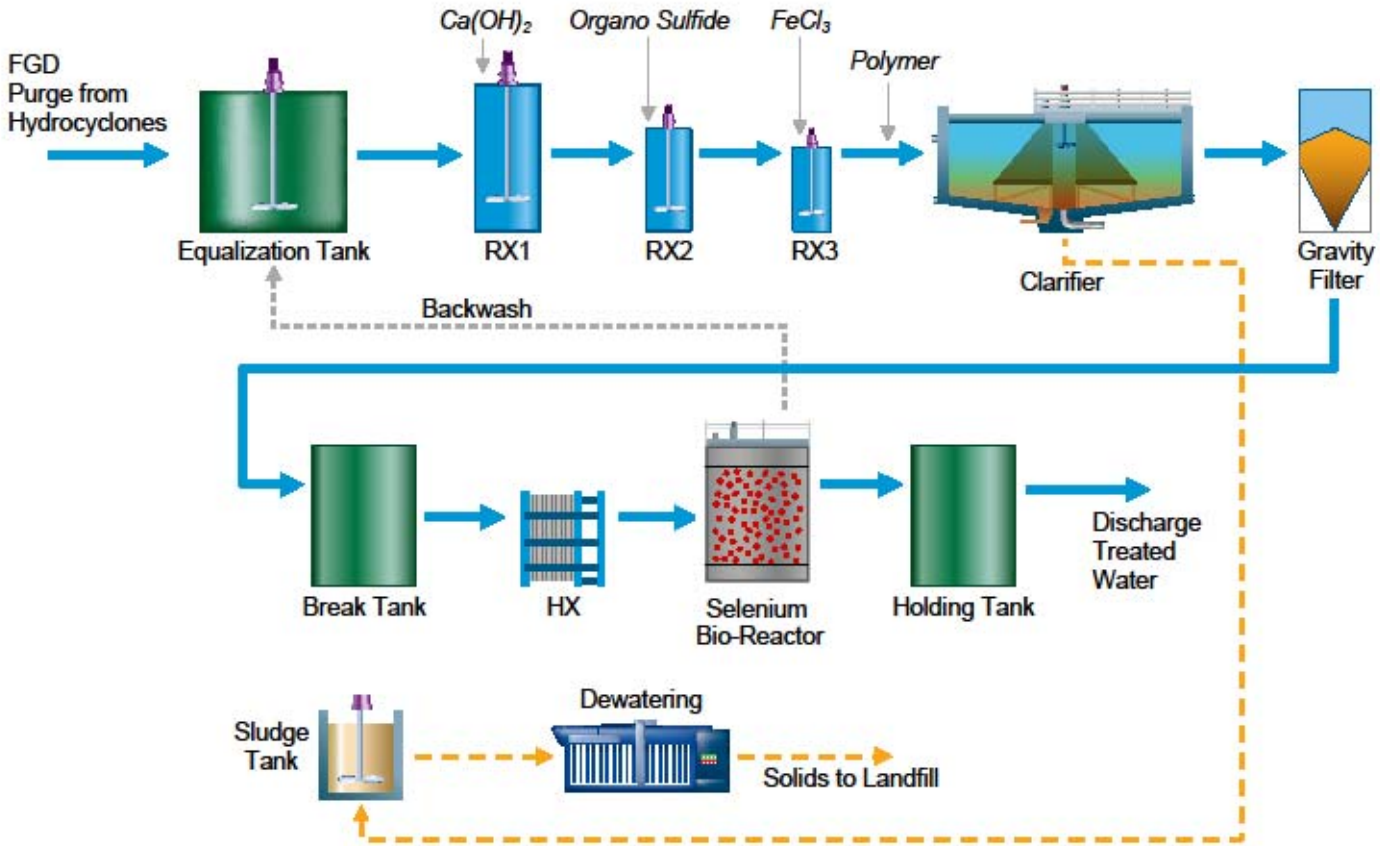
Cliffside 5 FGD WWTS

Biological Treatment Stages (if needed)

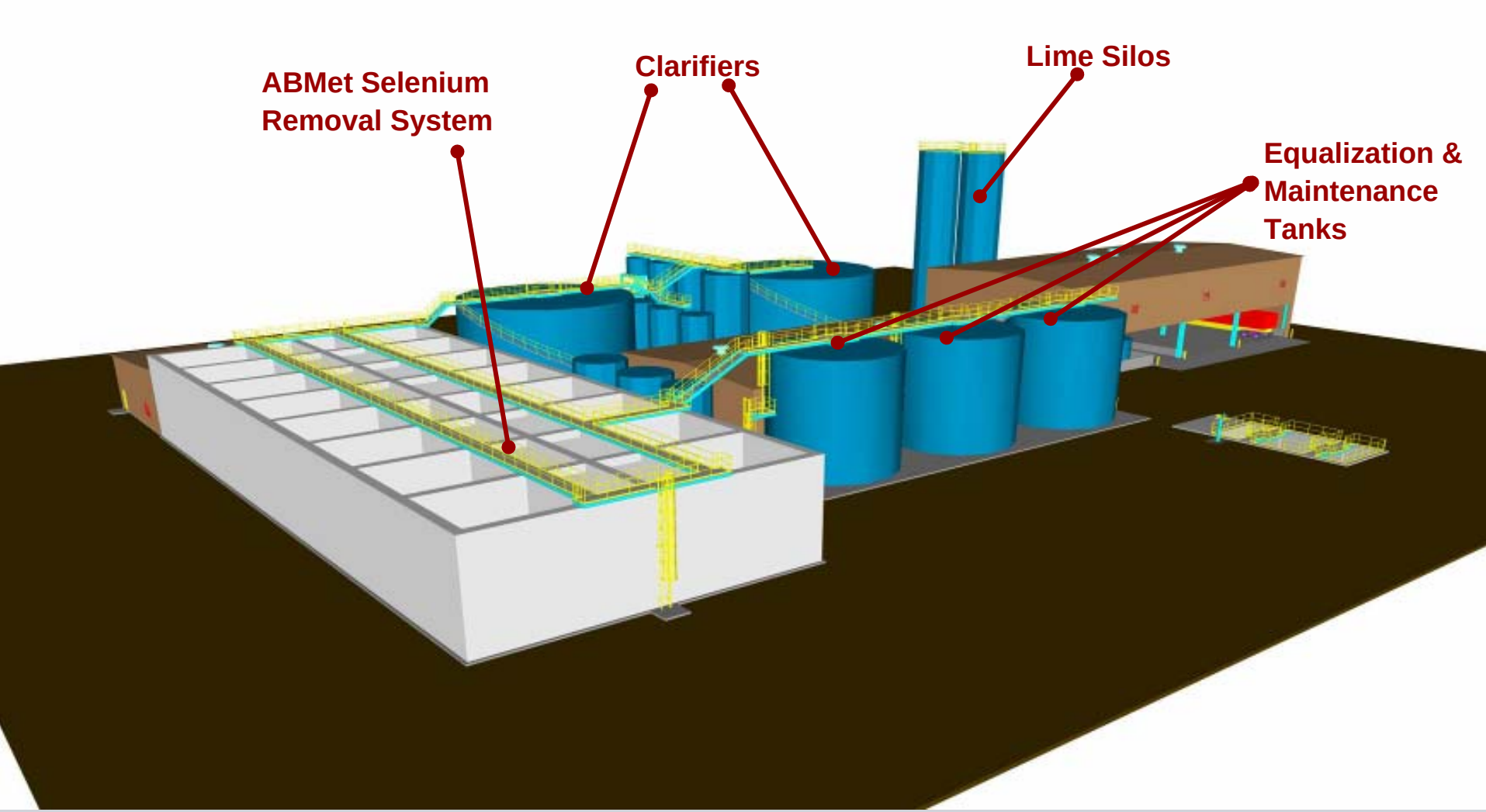
Performed *downstream of physical-chemical treatment*

- Selenium **removal** (ABMet System)
- Nitrogen removal
  - Activated Sludge, SBR
  - Attached growth in Special Filters
- COD removal
  - If organic acid used in FGD process
  - Suspended growth (e.g. Activated Sludge, SBR)

Physical Chemical Treatment and Selenium Reduction



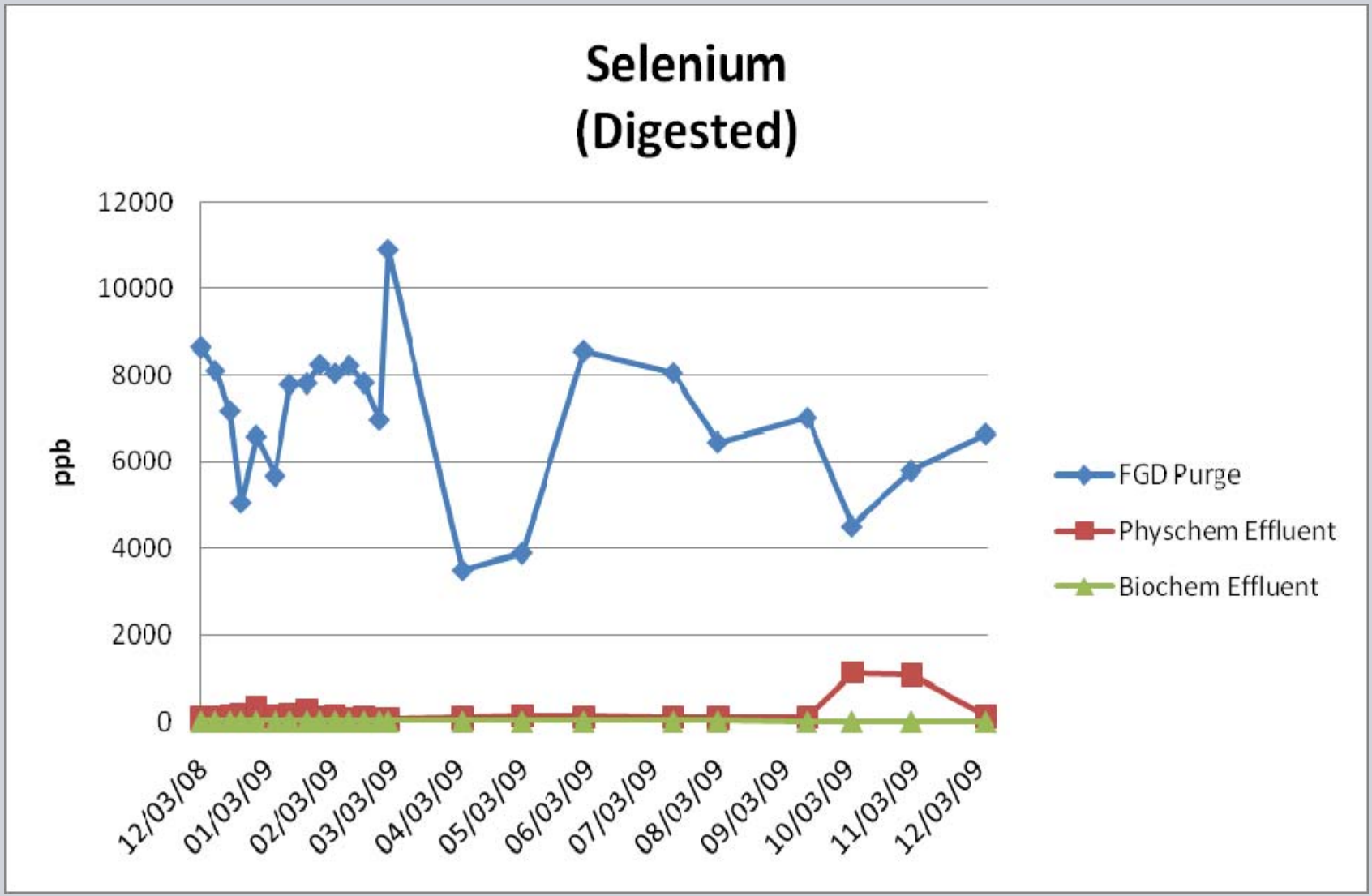
Belews Creek Integrated Treatment System



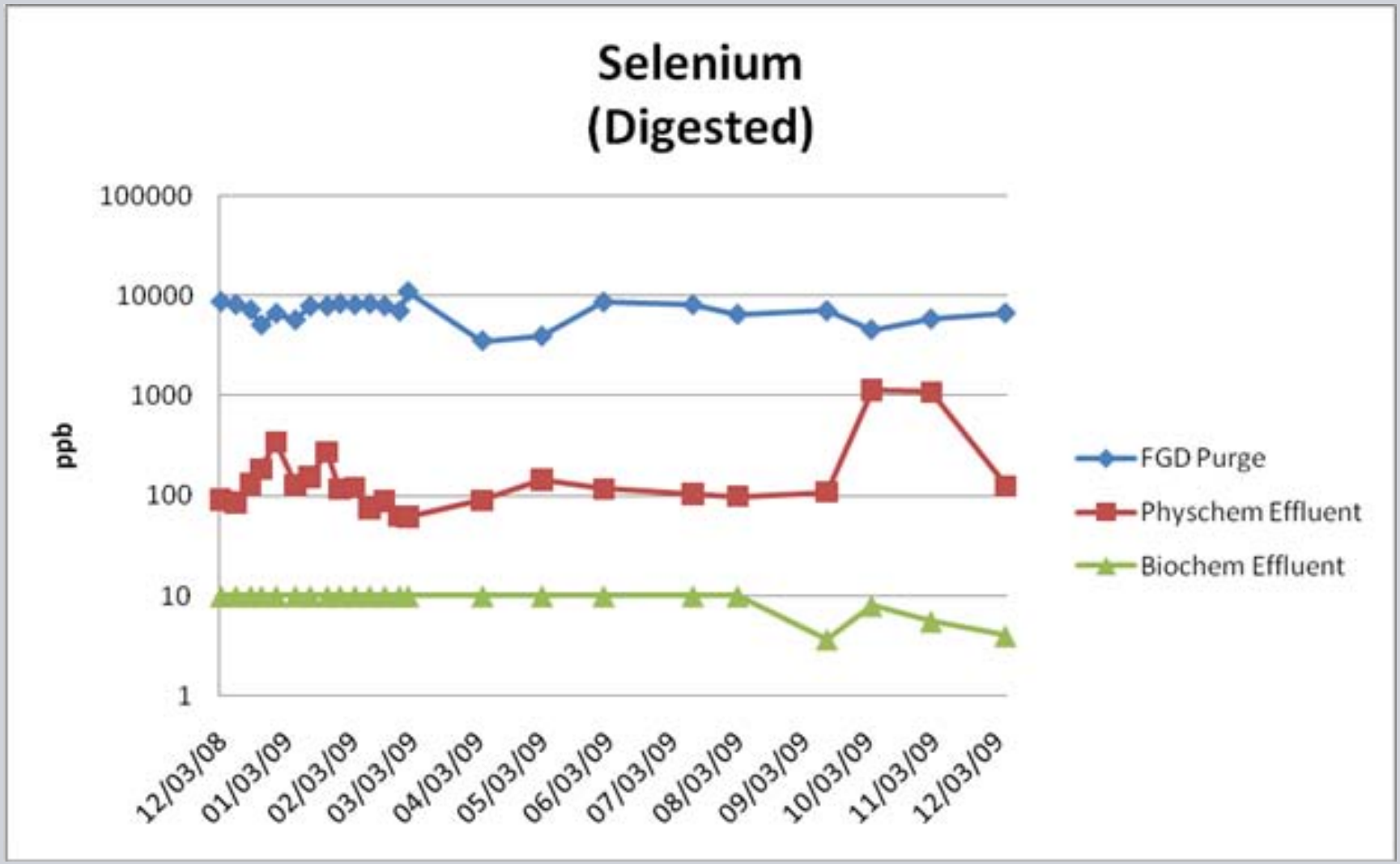
Completed Installation – Duke Energy Belews Creek Station

…Siemens Water Technologies also operates this installation on behalf of the Utility

Results – Actual Values



Results – Logarithmic Scale



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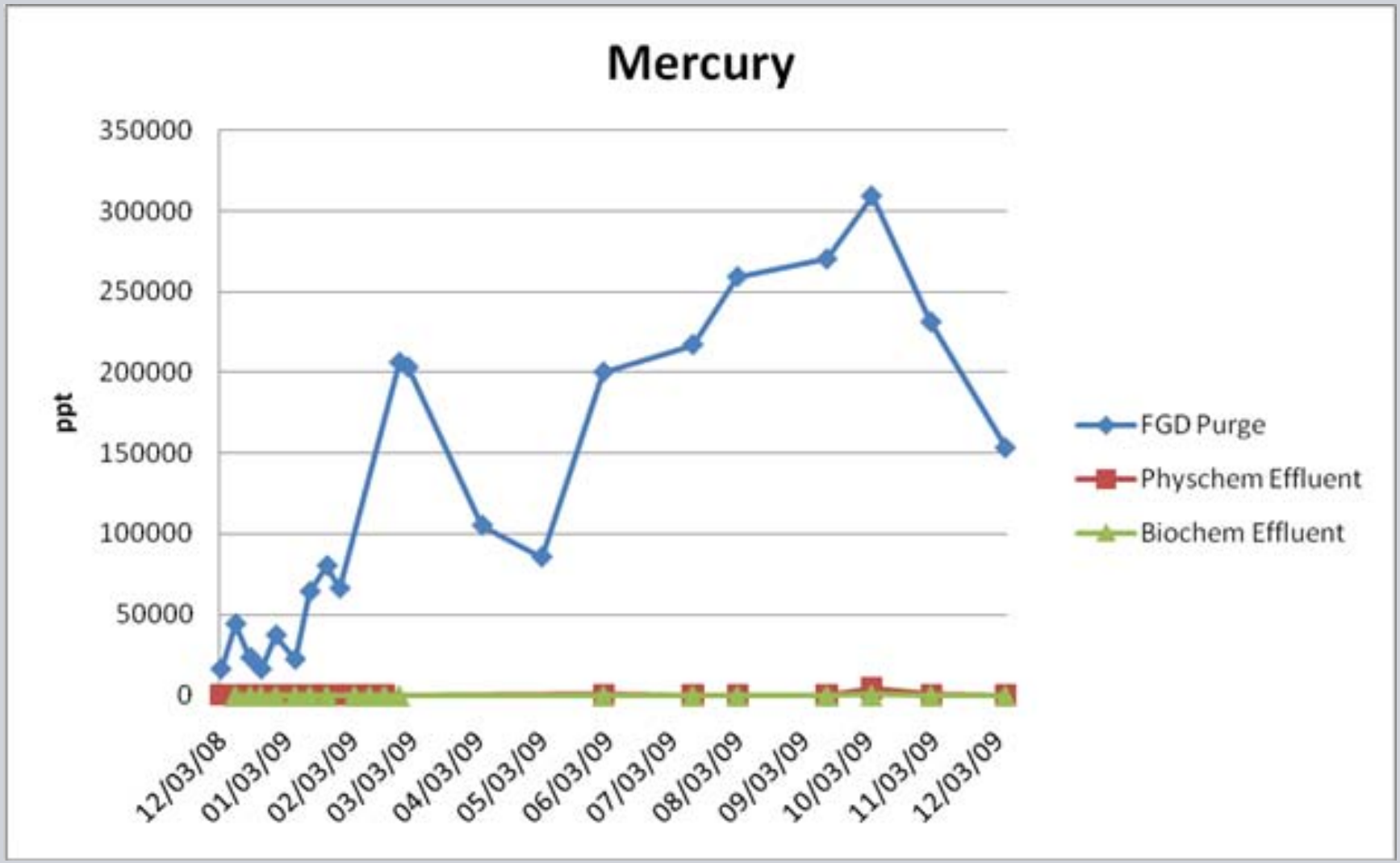

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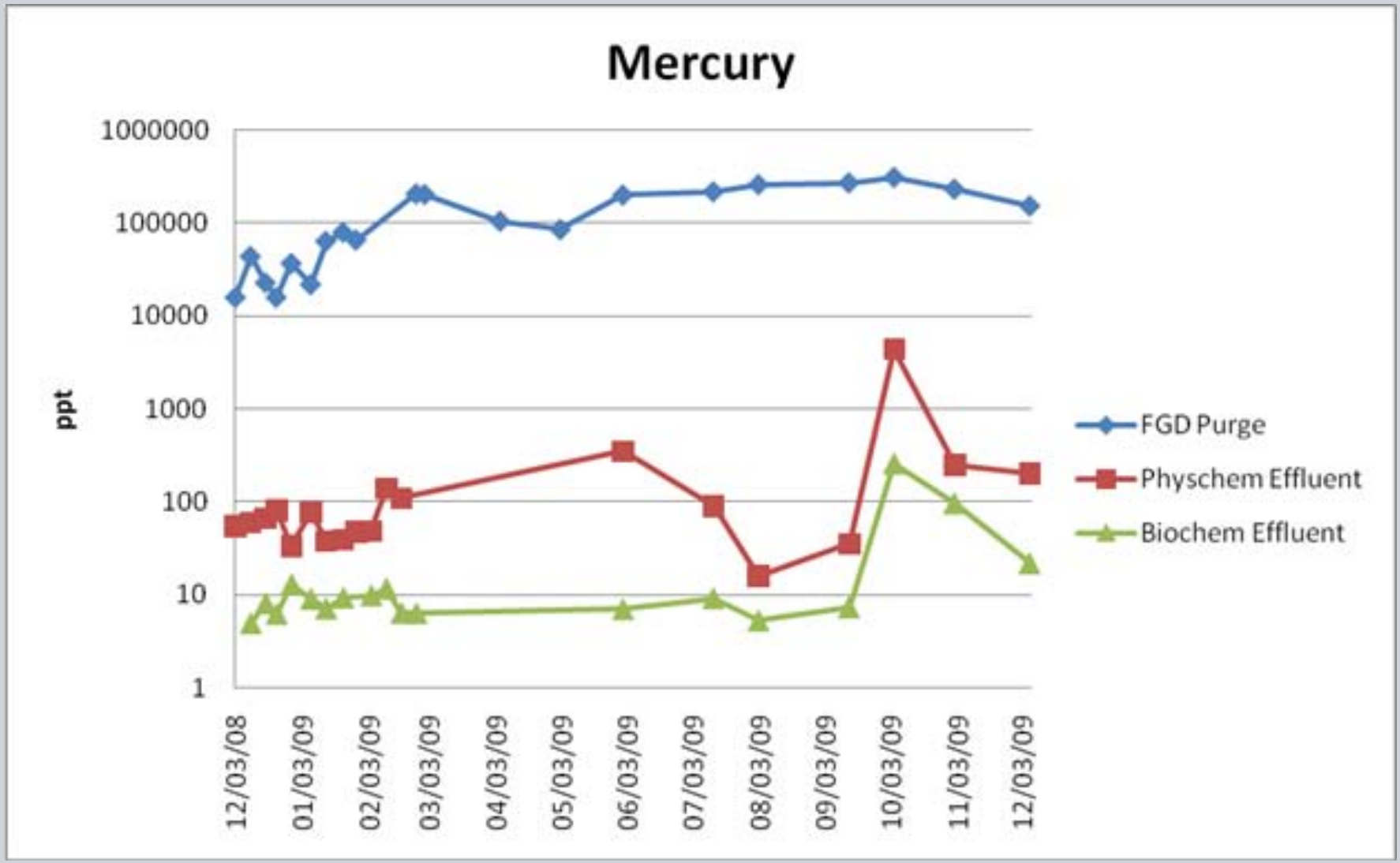
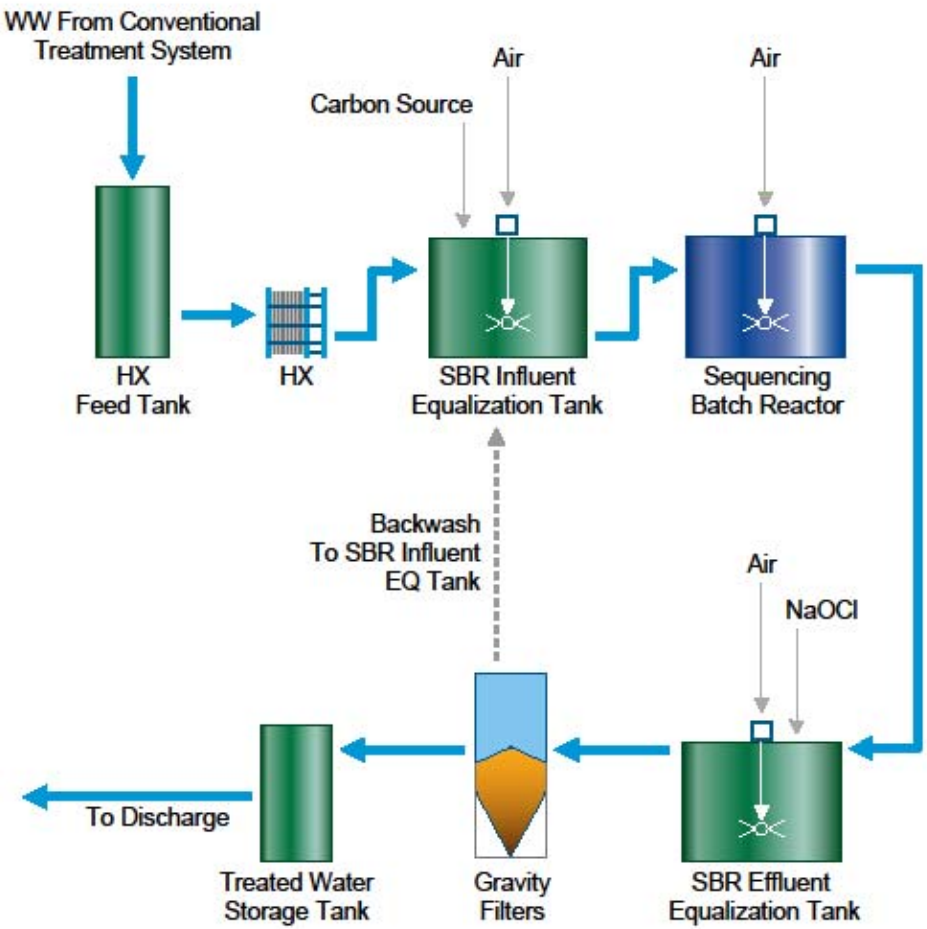
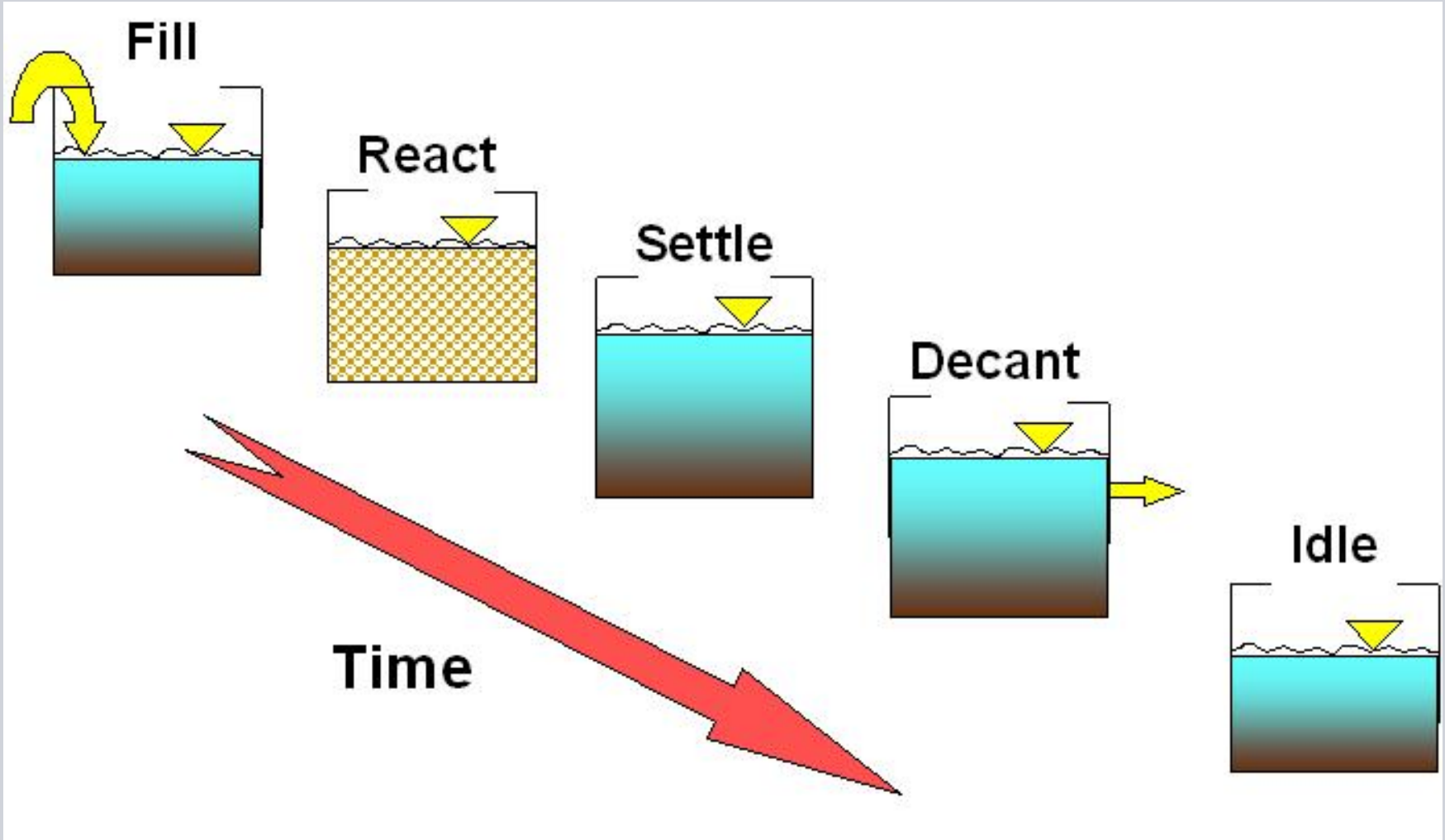


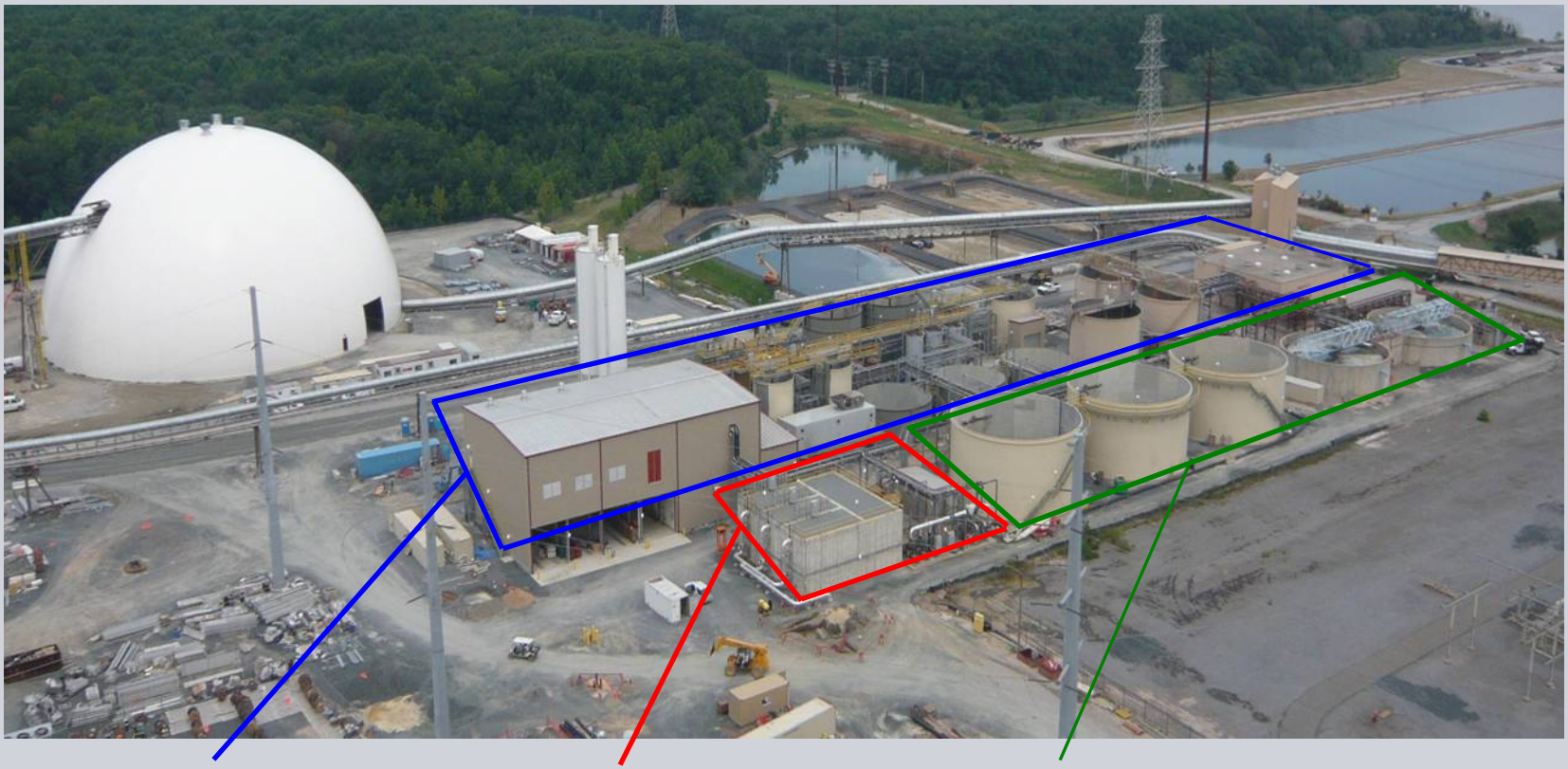
Nitrogen Reduction – following Physical Chemical Treatment



Sequential Batch Reactor for Reduction of Total Nitrogen



Physical Chemical Treatment with Biological Treatment for Nitrogen Removal



Treatment for Other Requirements

- What will the EPA and State Regulatory Agencies require in the future?

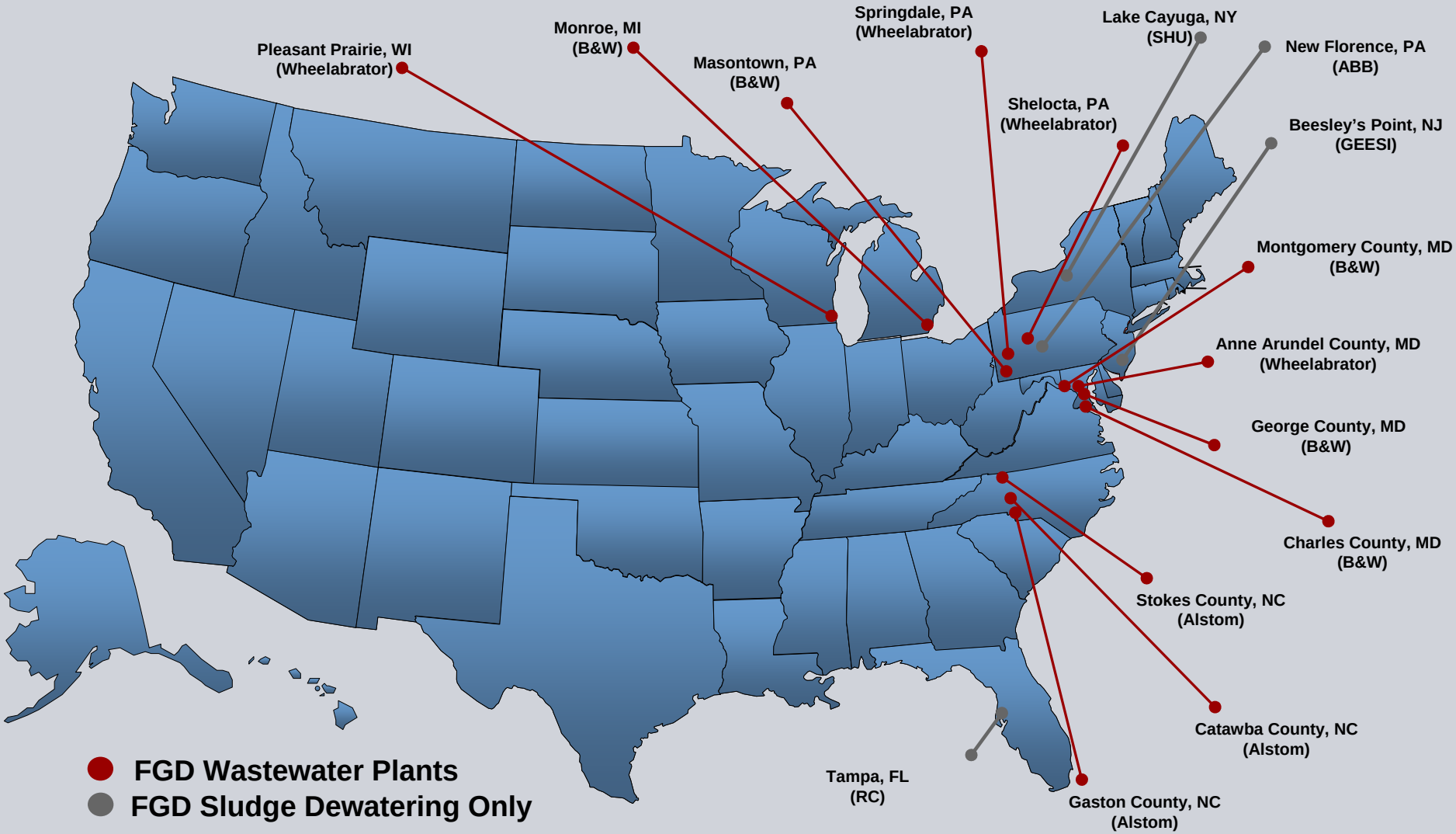
- Possible other contaminants
  - As, Ba, B, Be, Cd, Co, Cu, F, Mn, Mo, Pb, Tl, V

- Lower Levels than Current
  - Hg, Se

- Zero Liquid Discharge

- There are Solutions for Each Requirement

Our FGD WWTS Reference Base



Key Points to a Successful FGD Wastewater Treatment Project

- Allow the supplier to work closely with the utility, the utility's engineer, and the EPC to **value engineer** the design for each application
- Involvement **within** the Utility – O&M, Engineering, Environmental, Public Relations
- Experience in overall FGD system design, as well as specific wastewater treatment process design. **Copied designs don't work**
- **Careful selection** of all mechanical equipment and instrumentation, and particular attention to materials of construction
- Design must allow for the **variance** between actual and predicted wastewater quality and potential for changing regulations requiring future system modifications/additions.
- **Continuous Improvement** – in engineering and R&D to prepare for future requirements

Summary – FGD WWT

Technology is successfully being applied to meet current requirements.

Additional FGD retrofits and limited new coal-fired power plants will occur in the U.S. through the year 2020.

Only a portion will need WWTS.

Questions abound about future treatment requirements that will be imposed by federal and state governments.

Once the USEPA and state EPAs publish the new requirements, there are solutions to meet utilities' needs.

Further Questions can be directed to:
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Questions?

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