

REINHOLD ENVIRONMENTAL Ltd.



## **2018 APC & Wastewater Round Table & Expo Presentation**

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# **Industry Update: Bottom Ash Wet-to-Dry Conversion Design Considerations for FGD Make-Up Water**

Prepared for: 2018 APC-Wastewater/PCUG Conference

Presented By: Kevin L. McDonough

*23 July 2018*



# Safety Moment

# Discussion Overview



**Regulatory Considerations**

**Summary of Recent WTD Project Activity**

**Overview of Bottom Ash Technology for FGD Water**

**Water Balance and Water Quality Considerations**

# Discussion Overview



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# Key Regulatory Actions

## Coal Combustion Residuals (CCR)

- Issued December 19, 2014
- CFR Publication: April 17, 2015
- Goals
  - ✓ Groundwater Protection Benefits
  - ✓ Preventing Future CCR Impoundment Catastrophic Failures



## Effluent Limitations Guidelines (ELG)

- Proposed Rules Issued April 2013
- CFR Publication: November 03, 2015
- Goals
  - ✓ Strengthen Steam Electric Power Plant Discharge Controls
  - ✓ Reduce Surface Water Pollutant Discharges

# ELG Ruling

## EPA Stay on FGD Wastewater and Bottom Ash Transport Water



Wastestreams	Technology Basis
<b>FGD Wastewater</b>	Chemical Precipitation + Biological Treatment
<b>Fly Ash Transport Water</b>	Dry Handling / Closed-loop for units >50W; Impoundment (equal to BPT) for units <50MW
<b>Bottom Ash Transport Water</b>	Dry Handling / Closed-loop for units >50W; Impoundment (equal to BPT) for units <50MW
<b>Combustion Residual Leachate</b>	Impoundment (equal to BPT)
<b>FGMC Wastewater</b>	Dry Handling
<b>Gasification Wastewater</b>	Evaporation
<b>Nonchemical Metal Cleaning Wastes</b>	Chemical Precipitation

# ELG Ruling

## Final Rule Basis



Wastestreams	Technology Basis
FGD Wastewater	Chemical Precipitation + Biological Treatment
Fly Ash Transport Water	Dry Handling / Closed-loop for units >50W; Impoundment (equal to BPT) for units <50MW
<b>Bottom Ash Transport Water</b>	<b>Dry Handling / Closed-loop for units &gt;50W; Impoundment (equal to BPT) for units &lt;50MW</b>
Combustion Residual Leachate	Impoundment (equal to BPT)
FGMC Wastewater	Dry Handling
Gasification Wastewater	Evaporation
Nonchemical Metal Cleaning Wastes	Chemical Precipitation



- **Transport Water**

- Any wastewater that is used to convey fly ash, bottom ash, or economizer ash from the ash collection or storage equipment, or boiler, and has direct contact with the ash.
- Transport water does not include low volume, short duration discharges of wastewater from minor leaks (e.g. leaks from valve packing, pipe flanges, or piping) or minor maintenance events (e.g., replacement of valves or pipe sections).

- **Low Volume Waste Sources include:**

- Boiler blowdown
- Floor drains
- Recirculating house service water systems



- **Dry Ash Handling System**
  - Submerged Drag Chain System
  - Dry Pneumatic System
  - Dry Mechanical System
- **Closed-loop Recirculation System**
  - Conventional Dewatering Bin / Settling / Surge Tanks
  - Continuous Dewatering & Recirculation System with Remotely-located Submerged Flight Conveyors (CDR)
  - Dewatering Basin Recirculation System
- **FGD Source or Make-Up Water Feed System**
  - Viability based on Bottom Ash & FGD Water Requirements
  - Must Investigate BA System vs. FGD System Water Balances

# Bottom Ash Transport Water as FGD Water Source

## ELG Requirements



- “When the bottom ash transport water is used in the FGD scrubber, the quantity of pollutants in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of bottom ash transport water times the concentration listed in the table in paragraph (g)(1)(i) of this section.”

Pollutant or Pollutant Property	BAT Effluent Limitations	
	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, total (mg/L)	17	4.4

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# UCC Wet-to-Dry Ash Conversion Update

WTD Projects Awarded to UCC (2009-2018)

Presentation Prepared For:



Project Type	# of Projects Awarded	# of Units Converted
Bottom Ash Wet-to-Dry Conversions	<b>52</b>	<b>112</b>
Fly Ash Wet-to-Dry Conversions	<b>25</b>	<b>56</b>



# UCC Wet-to-Dry Ash Conversion Update

Coal Units: Dry Ash Handling Systems

Presentation Prepared For:



Project Type	Unit Conversion %
% of U.S. Fleet installed with or converted to Dry Fly Ash (Includes Projects In Progress)	<b>&gt;97%</b>
% of U.S. Fleet installed with or converted to Dry Bottom Ash (Includes Projects In Progress)	<b>Approx. 50%</b>



# UCC Wet-to-Dry Ash Conversion Update

Summary of Recent UCC Bottom Ash WTD Activity

Presentation Prepared For:



<b>UCC PAX System</b>	<ul style="list-style-type: none"><li>• (5) Operating Systems</li><li>• (4) New Projects in Progress with Systems Operational in 2018/2019/2020</li><li>• Increasing Utility &amp; Industrial Market Interest in 100% Dry Solution (eliminates wastewater)</li></ul>
<b>UCC SFC System</b>	<ul style="list-style-type: none"><li>• (18) New SFC projects in last (4) years</li><li>• (7) New Projects in Progress</li><li>• (2) Additional Pending Awards</li><li>• Likely First Choice if Space Permits</li></ul>
<b>UCC CDR System</b>	<ul style="list-style-type: none"><li>• (8) Operating Systems (since 2012)</li><li>• (12) New Projects in Progress with Systems Operational in 2018/2019/2020</li><li>• Often Preferred if Under-Unit SFC will not fit</li></ul>



# Technical Design Considerations

Wet-To-Dry Ash Conversion Project Design Criteria	
Budget	Plant Water Balance Considerations
Outage Requirements	Ash Conveying Capacities
Physical Parameters	Conveying Distance Considerations
Site Environmental Considerations	Operations & Maintenance Issues
Ash Characteristics	Multiple Unit Synergies
Ash Marketability/Beneficiation	Unburned Carbon Concerns

- Evaluate Criteria Against Multiple Alternatives
- Determine Optimal Solution for each Plant
- “One Size Does Not Fit All”

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**Overview of Bottom Ash Technology for FGD Water**

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# Continuous Dewatering & Recirculation (CDR) System



# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's



- CDR System with Remote SFC's
- Combines SFC Technology with Conventional Recirculation System

# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:





# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's



# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:



**UCC Remote SFCs**

# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:



**UCC Bottom Ash and Pyrites Remote SFCs**

# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:



## ■ Technical Design Features

### ■ Reduced Equipment Scope

- Combines Dewatering and Particulate Settling into Single Unit

### ■ Provides Multiple Unit Synergies

- Can Receive Sluice Lines from Multiple Units

### ■ Reduced Foundation Design Requirements

- Smaller Footprint than Traditional BA WTD Systems
- Reduced Construction Costs

### ■ Consistent Bottom Ash Dewatering

- Continuous Dewatering Up SFC Incline Section
- Dewateres Bottom Ash to Moisture Levels Suitable for Landfill Disposal or Beneficial Use



# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's



# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:



# Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:



**Bottom Ash moisture content  
low enough to readily pass  
EPA Paint Filter Test**



# Remote SFC & Clarifier System



### ■ Technical Design Features

#### ■ Uses Proven SFC & Clarifier Technologies

- Similar features/benefits of CDR System
- Additional Clarification Phase to reduce particulate carryover (TSS)
- Can be recycled or designed for once-through system

#### ■ Once-Through System

- Bottom Ash Sluice Water may be used as a make-up water source for FGD System (per Effluent Limitations Guidelines)
- Can be designed for TSS levels suitable for Recirculation Pumps

# Bottom Ash WTD Conversion Alternatives

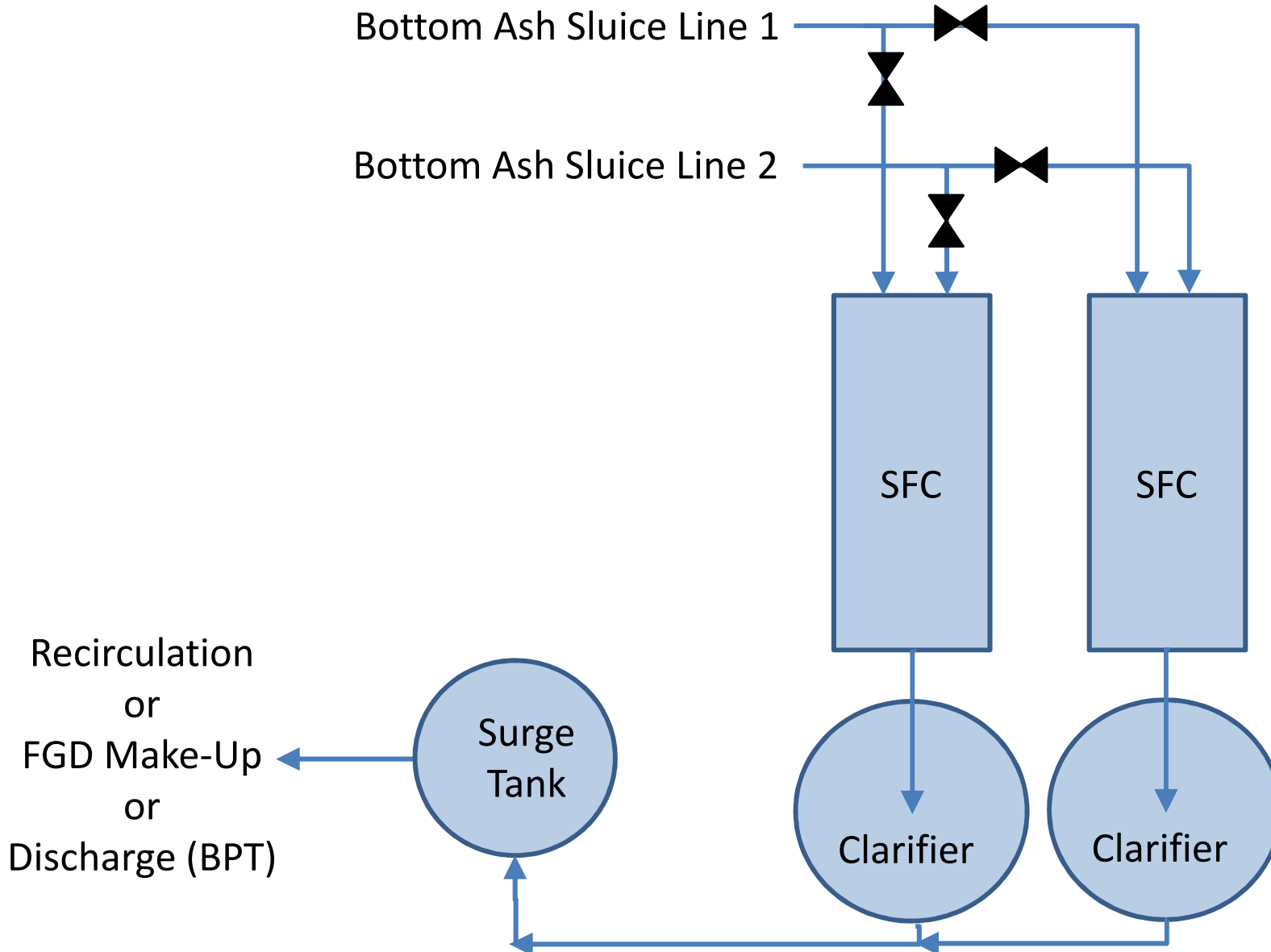
UCC CDR System with Remote SFCs and Clarifiers

Presentation Prepared For:



# Bottom Ash WTD Conversion Alternatives

UCC CDR System with Remote SFCs and Clarifiers



# Design Basis Requirements

## Typical Performance Guarantees



Parameter	Performance Requirement
TSS (in R-SFC Overflow)	400 ppm (24-hour average)
TSS (in Clarifier Overflow)	100 ppm (daily maximum) 30 ppm (monthly average)
Moisture % (Bottom Ash)	20% in bunker after 24 hours or Paint Filter Test

# Bottom Ash WTD Conversion Alternatives

UCC CDR System with Remote SFCs and Clarifiers

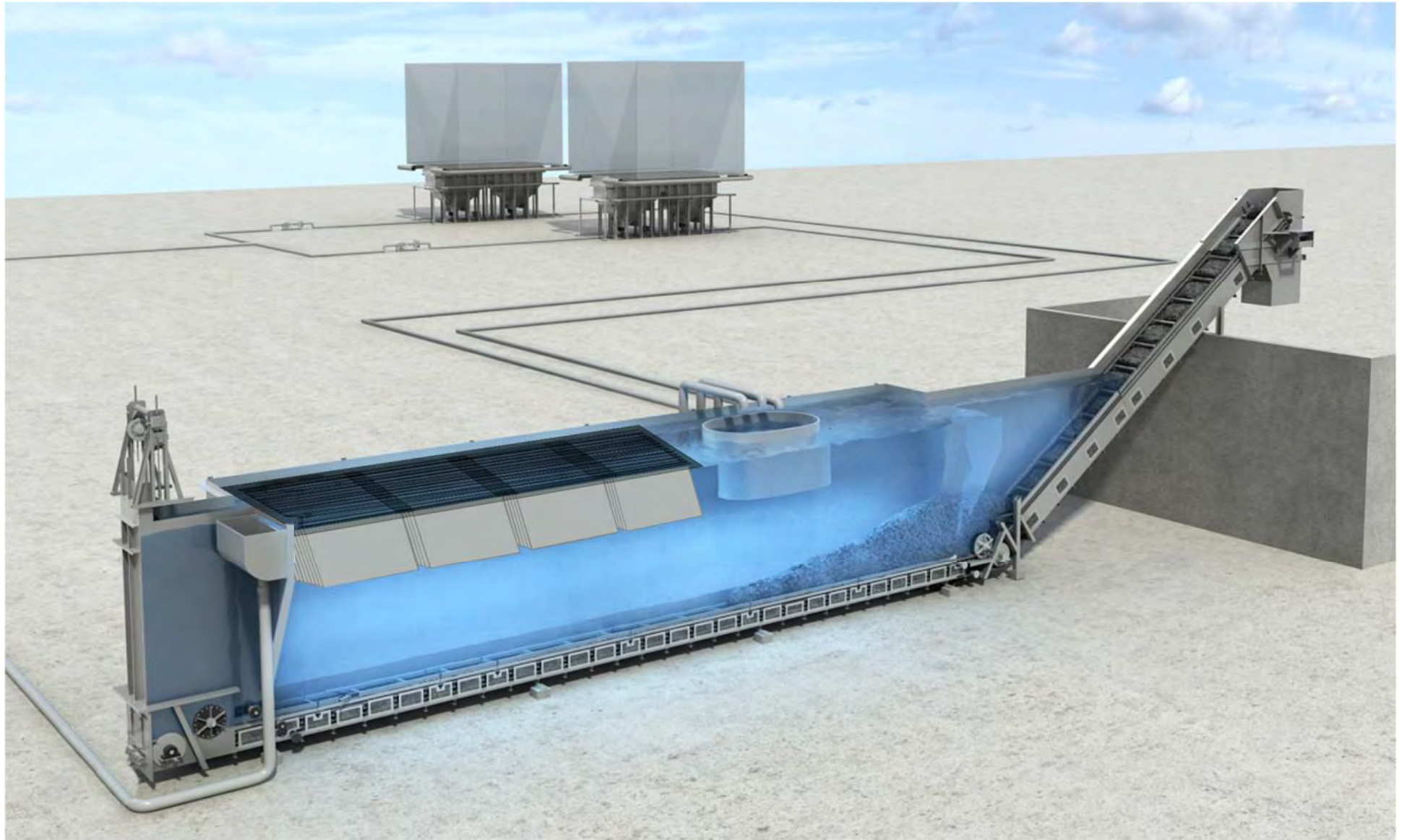
Presentation Prepared For:



# Water Balance/Wastewater Considerations

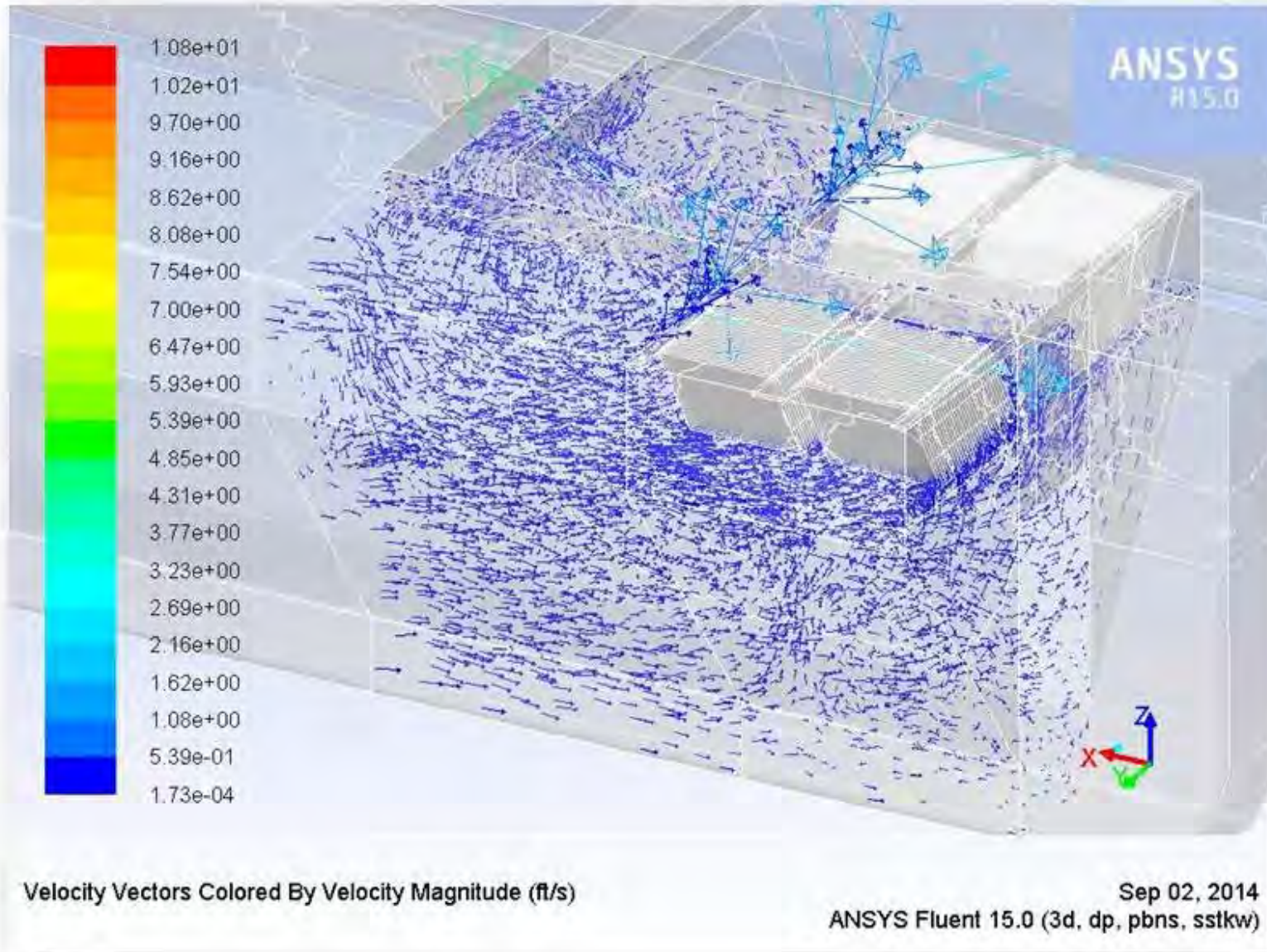
TSS Control: UCC Lamella Design

Presentation Prepared For:



# Water Balance/Wastewater Considerations

## TSS Control: UCC Lamella Design





# Bottom Ash WTD Conversion Alternatives

## UCC CDR System with Remote SFCs and Clarifiers



# Bottom Ash WTD Conversion Alternatives

UCC CDR System with Remote SFCs and Clarifiers

Presentation Prepared For:



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Presentation Prepared For:





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# Water Balance/Wastewater Considerations

## Bottom Ash Sluice Water Demands for CDR Systems

### Typical Water Requirements:

- High Pressure Sluice Conveying Water = 2,500-3,500 gpm
- Low Pressure Cooling Water/Seal Trough Flushing/Make-Up Water Supply = 150-300 gpm/unit





## Water Balance Key Considerations

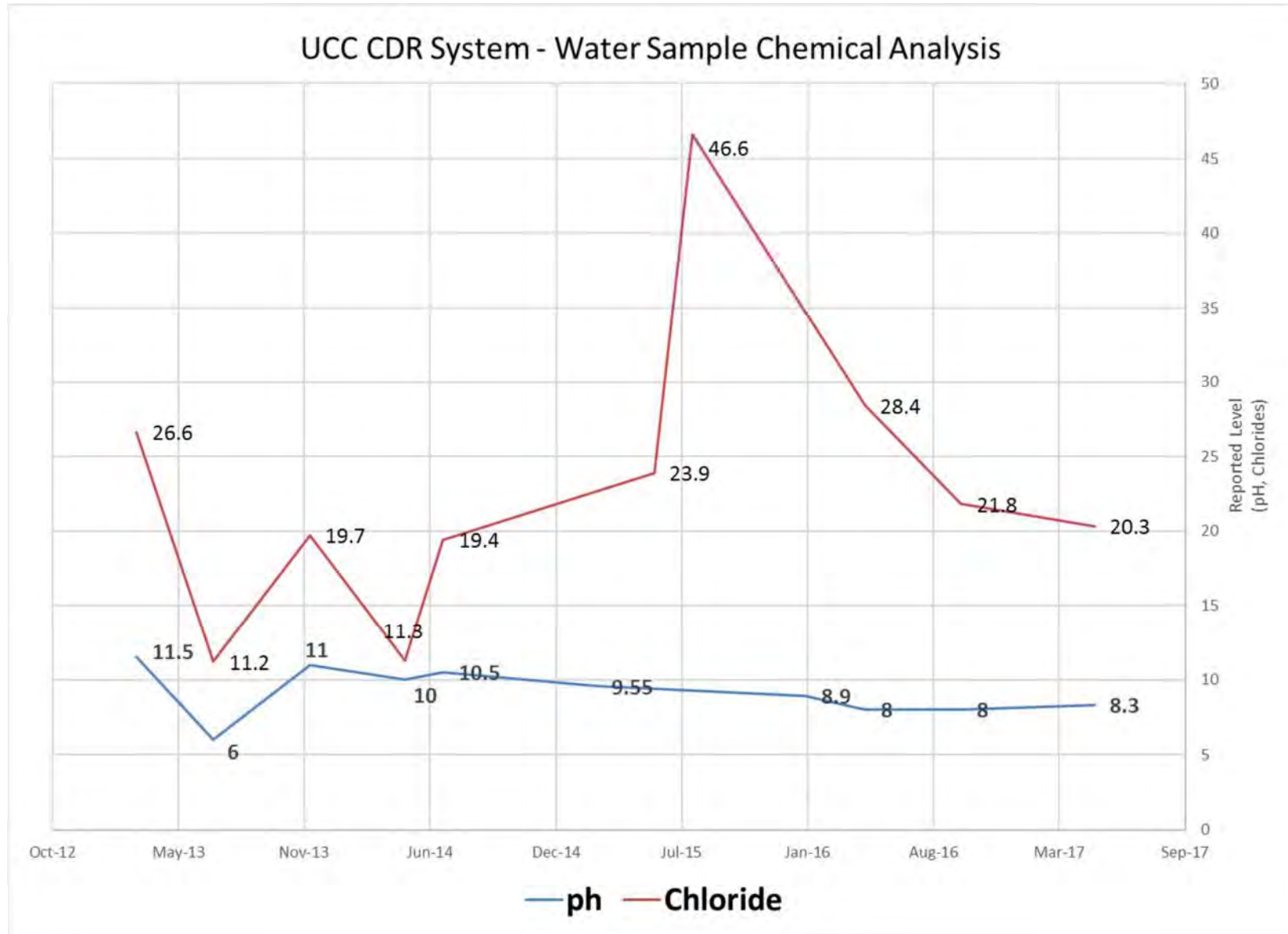
- **Losses**
  - Evaporation
  - Water Retention in Ash
  - Hopper Leakage
  - Seal Trough Flushing
- **Gains**
  - Chain Sprays – SFC (for CDR System)
  - Seal Water from Pumps (if not mechanical)
  - Rain
- **Will Have Net Loss of Water from System**
- **Water Balance can be complex**



- **Comparing Average pH levels by Coal Type:**
  - Eastern Bituminous: 6.81
  - Lignite: 5.40
  - PRB: 7.22
  - Western Coals (Non-PRB): 8.47
- **pH Control Measures:**
  - Caustic Addition for High Sulfur Coals (NaOH)
  - Acid Addition for PRB Coals
  - Most installed systems not currently in use
- **Chloride Concentrations:**
  - No consistent data for Chloride concentrating
  - Potential blowdown considerations, but only if necessary

# Water Balance/Wastewater Considerations

## Bottom Ash Sluice Water Quality and Chemistry



# UCC Bottom Ash WTD Conversion Alternatives

## Bottom Ash Sluice Water Quality and Chemistry

Presentation Prepared For:



- **Some plants have experienced low pH conditions in CDR Systems**
- **Seems to vary by boiler type and operating load**
- **UCC Solution: pH Control Modules**
  - Design and Supply: \$30-40K/Unit
  - Installation: \$40-50K/Unit
  - Approximate Injection Rate (25% sodium hydroxide solution): 0.042 gallons/hour to 0.875 gallons/hour
  - The injection rate appears to correspond to load. At lower loads, the rate goes up. At higher loads, the rate goes down.

# UCC CDR System with Remote SFCs & Clarifiers

## Design Requirements and Operating Results

Presentation Prepared For:

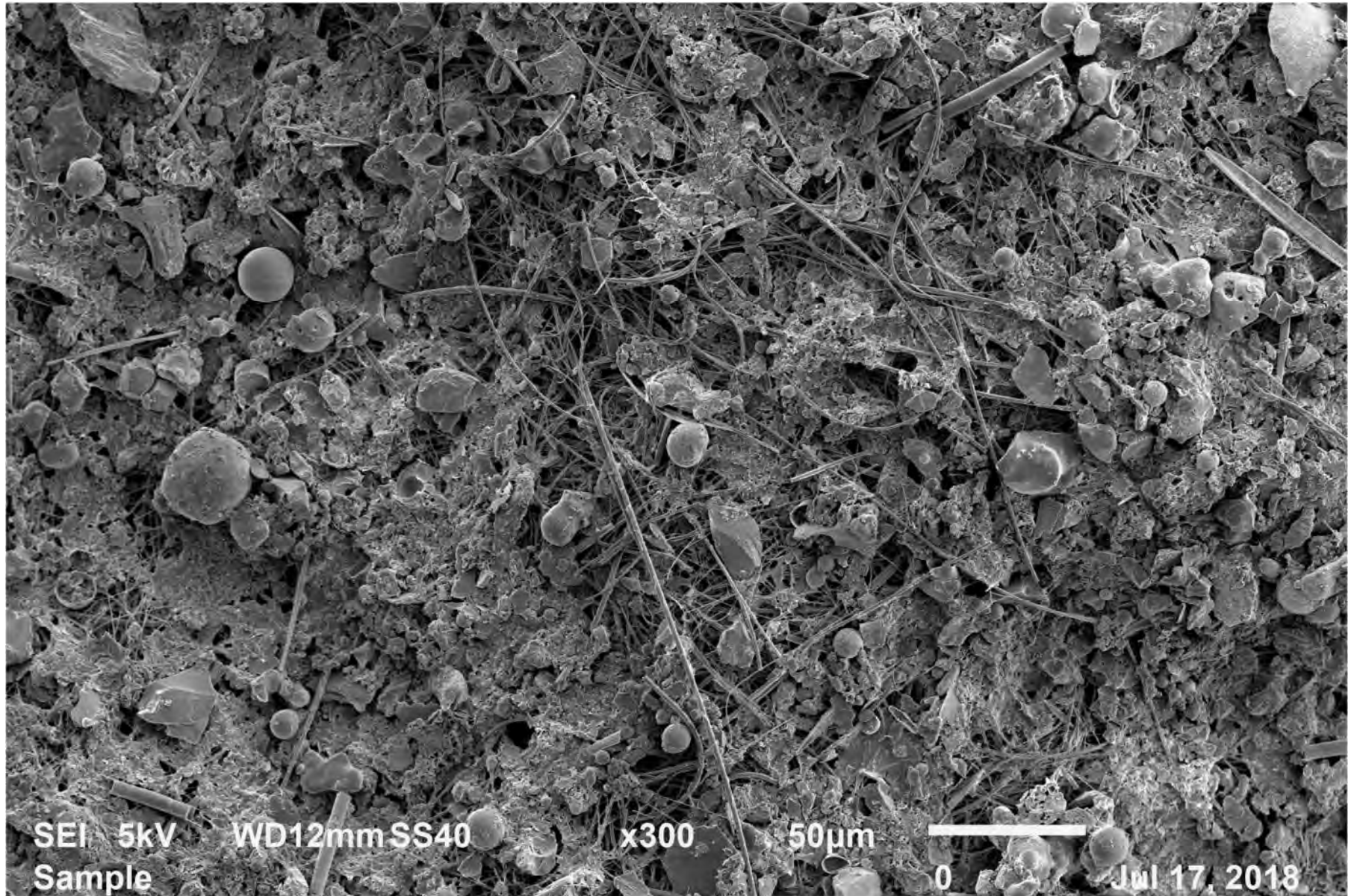


	Specified Design		Actual
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)	Typical Daily Sample
<b>TSS</b>	100.0 ppm	30.0 ppm	<15ppm
<b>Oil and Grease</b>	20.0 ppm	15.0 ppm	<15ppm
<b>pH</b>	6-9		7.5

# UCC R-SFC & Clarifier System

Design Requirements and Operating Results

Presentation Prepared For:



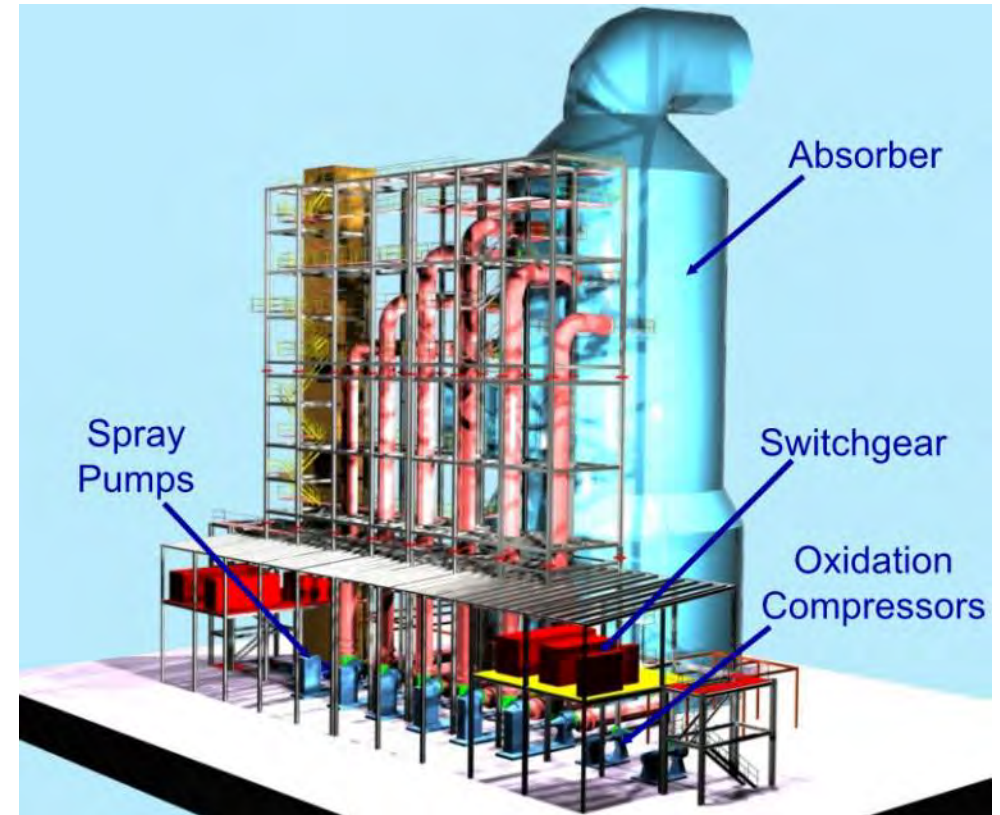
# Water Balance/Wastewater Considerations

## FGD Process Water Flow Requirements

Presentation Prepared For:



- **High FGD Flow Applications**
  - 1800 – 2700 gpm
- **Low FGD Flow Applications**
  - 500 – 800 gpm



# High Level Water Balance

Bottom Ash Transport Water as Make-Up Source for FGD Process Water

Presentation Prepared For:



High Flow FGD Application	Continuous Flow (gpm)	Total Volume Per 12 Hour Shift (gallons)
<b>FGD Process Water</b>	1,800	1,296,000
<b>Bottom Ash Transport Water</b> (*assumes 4 hour sluice cycle)	3,000*	720,000
<b>Difference (required FGD Make-Up Water)</b>	800	576,000

# High Level Water Balance

Bottom Ash Transport Water as Make-Up Source for FGD Process Water

Presentation Prepared For:



Low Flow FGD Application	Continuous Flow (gpm)	Total Volume Per 12 Hour Shift (gallons)
<b>FGD Process Water</b>	650	468,000
<b>Bottom Ash Transport Water</b> (*assumes 4 hour sluice cycle)	3,000*	720,000
<b>Difference (required FGD Make-Up Water)</b>	-350	-252,000

# Bottom Ash Transport Water as FGD Water Source

UCC CDR System with Remote SFCs and Clarifiers

Presentation Prepared For:



- **Confirm Flow Rates for WFGD and Bottom Ash Sluice Conveying Water**
- **Confirm Operating Sequence for Bottom Ash System (# Sluice Cycles per shift x Qty. of Units)**
- **Perform Water Balance Calculations**
- **Confirm Net Flow Requirements**
- **Take Water Samples of existing Bottom Ash Sluice Water (TDS, TSS, pH)**
- **Evaluate Return Water System Technical Requirements and Cost**

# Bottom Ash WTD Conversion Alternatives

UCC CDR System with Remote SFCs and Clarifiers

Presentation Prepared For:





# Questions ?

