

REINHOLD ENVIRONMENTAL Ltd.



2016 NO_x-Combustion-CCR Round Table Presentation

February 1 & 2, 2016, in Orlando, FL / Hosted by OUC

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Bottom Ash Conversions in Light of CCR and ELG

Tyler Little, Allen-Sherman-Hoff, Advanced Applications Engineer

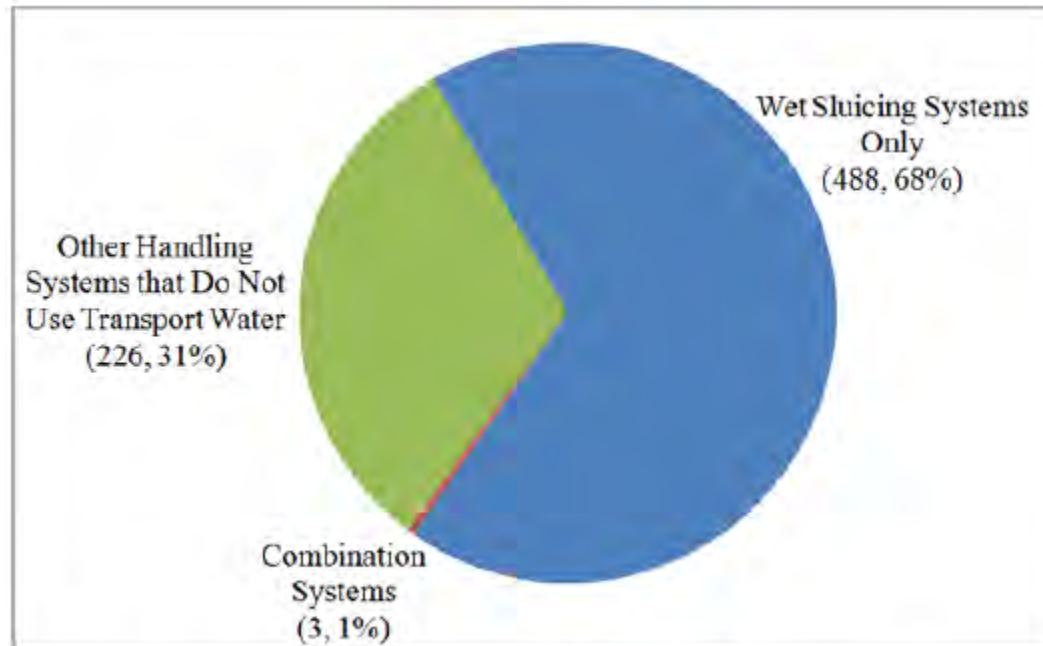


February 1, 2016

Outline

- ▶ Regulatory landscape for bottom ash handling
- ▶ Technology overview
- ▶ Water management
- ▶ Water quality issues
- ▶ Preparing for system conversion

Current Bottom Ash Handling Landscape



Coal- and Petroleum Coke-Fired Units

TDD, EPA-821-R-15-007

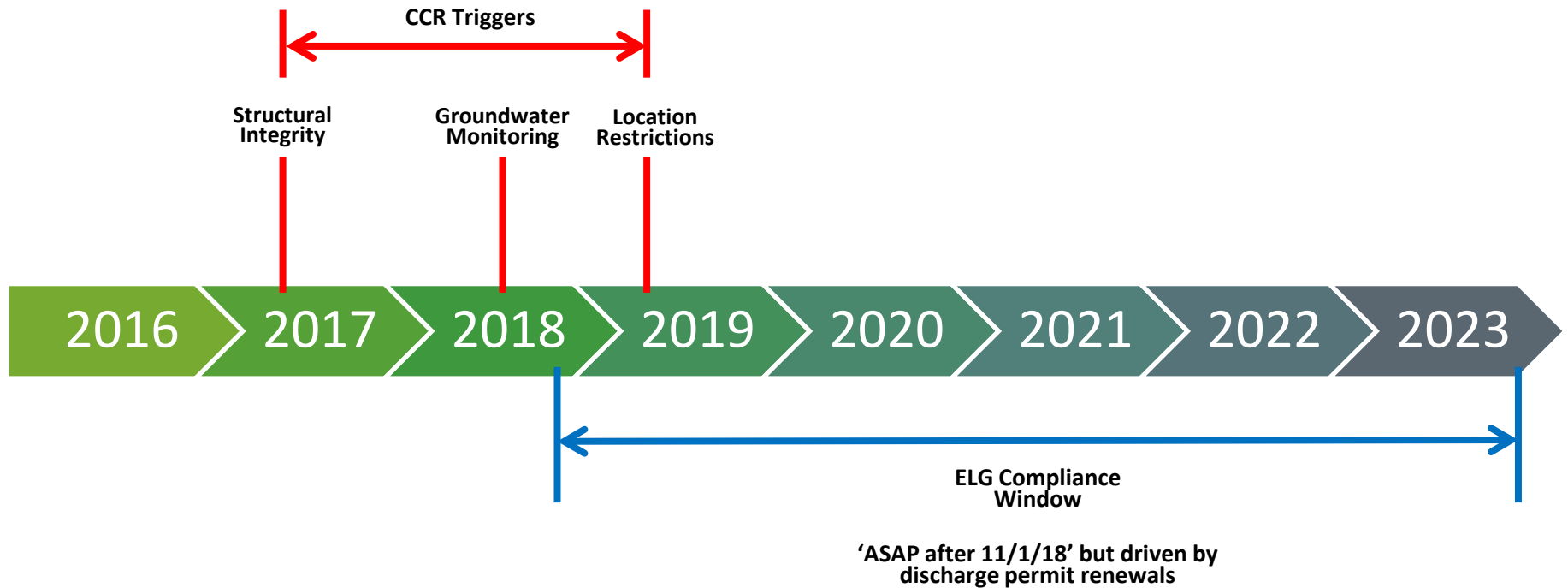
ELG (for units > 50 MW)

Wastestreams	Technology Basis
FGD Wastewater	Chemical Precipitation + Biological Treatment
Fly Ash Transport Water	Dry Handling
Bottom Ash Transport Water	Dry Handling/Closed Loop
FGMC Wastewater	Dry Handling
Gasification Wastewater	Evaporation
Combustion Residual Leachate	Impoundment
Nonchemical Metal Cleaning Waste	[Reserved]

CCR Requirements for Ash Ponds

- ▶ Location Restrictions
- ▶ Design Criteria
- ▶ Structural Integrity
- ▶ Air Criteria
- ▶ Hydrologic & Hydraulic Capacity
- ▶ Inspections
- ▶ Groundwater Monitoring and Corrective Action
- ▶ Closure and Post-Closure Care
- ▶ Recordkeeping, Notification, and Internet Requirements

Timeline for Ceasing CCR Input to Ash Ponds



Bottom Ash Conversion Deadlines

Can I operate in closed loop?

No

Yes

ELG

Pass structural integrity?

Pass groundwater monitoring?

Pass location restrictions?

Pass structural integrity?

Pass groundwater monitoring?

Pass location restrictions?

CCR

Yes

No

Yes

No

Yes

No

Yes

No

Yes

No

Yes

No

Nov. 2018 - Dec. 2023

April 2017

Nov. 2018 - Dec. 2023

July 2018

Nov. 2018 - Dec. 2023

April 2019



April 2017



July 2018



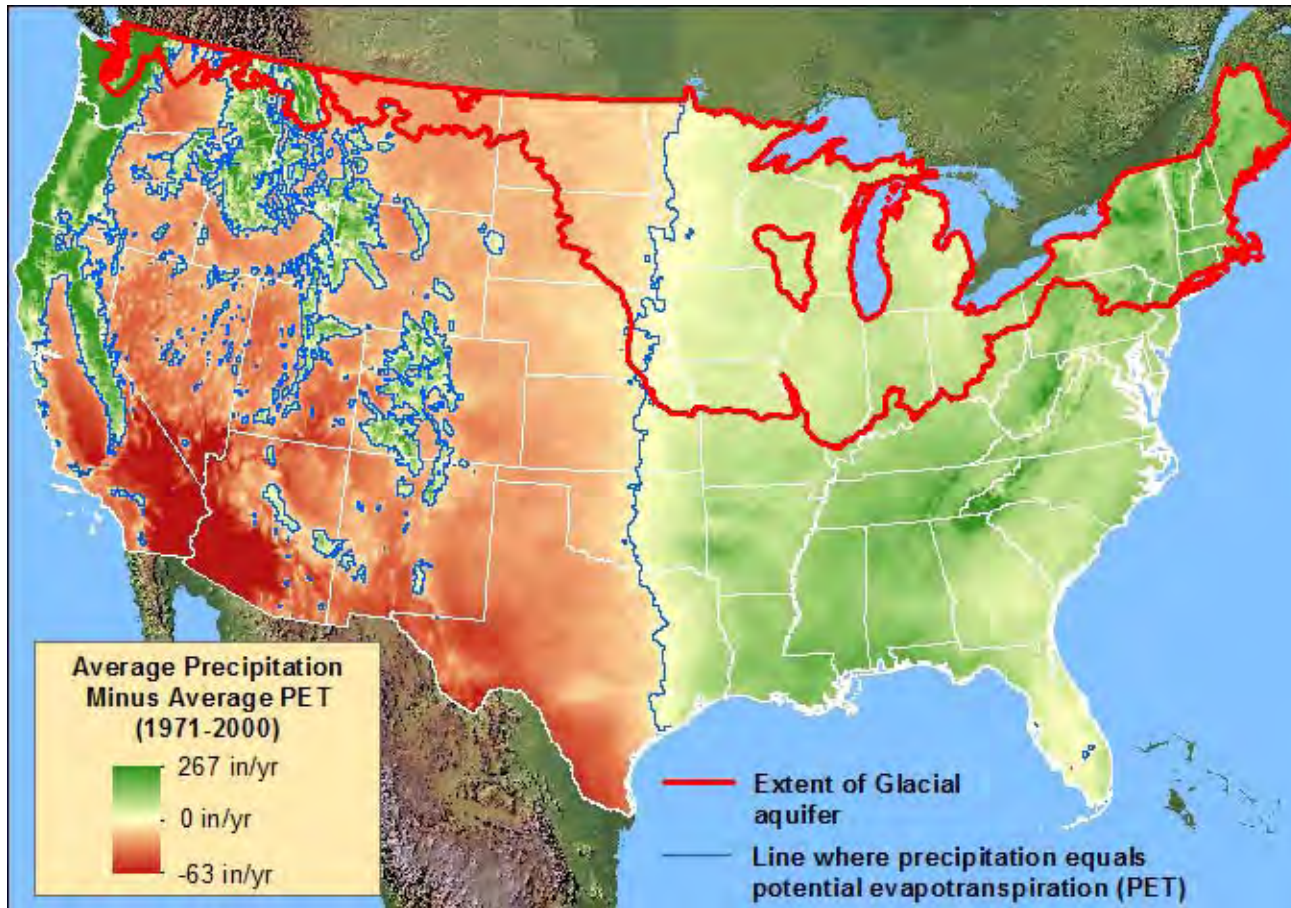
April 2019



What does 'Closed Loop' really mean?

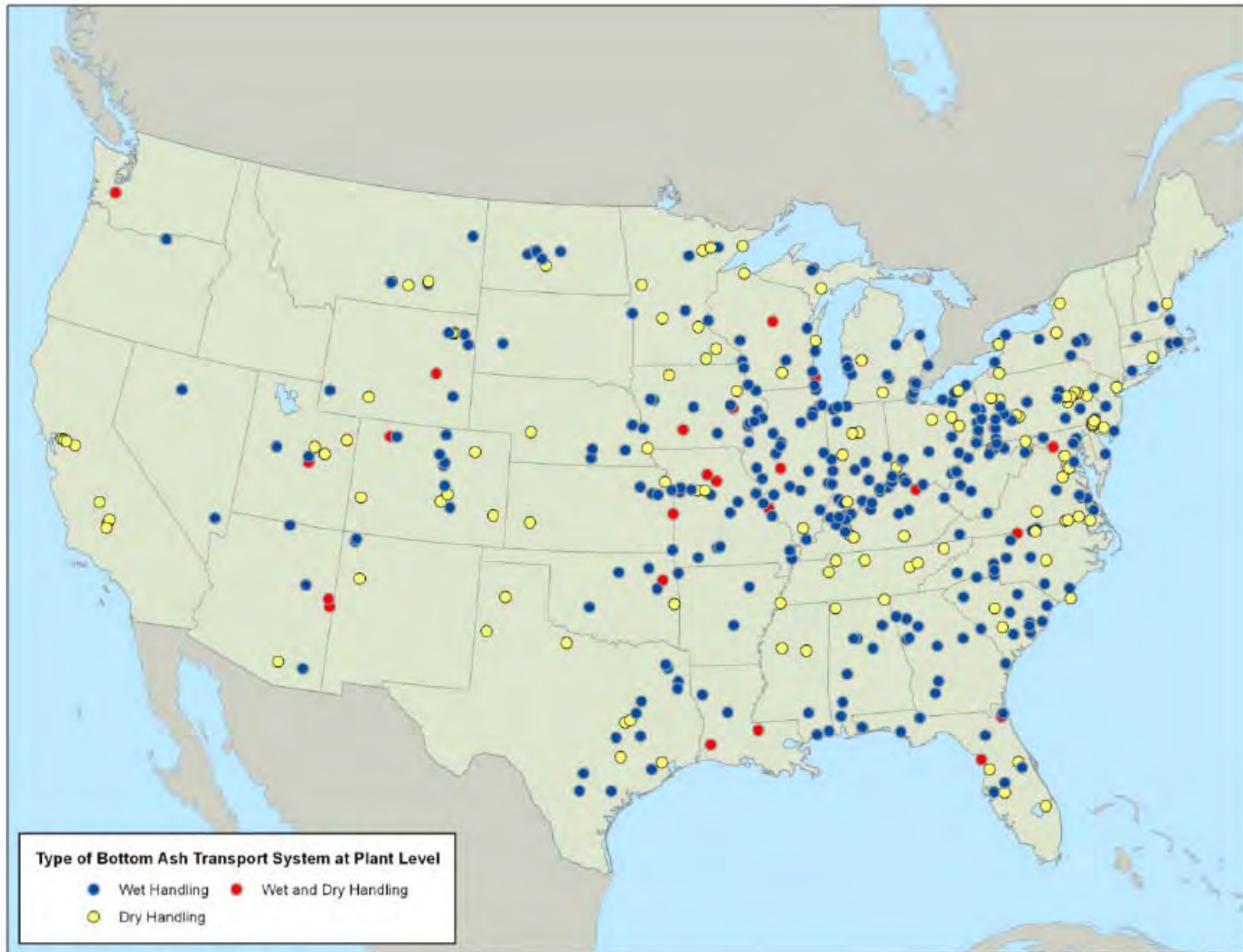
- ▶ Zero discharge of transport water from a contained system
 - Recirculation with ponds
 - No pond overflow
 - Rely on evaporation & rain water controls
 - May require periodic CCR removal from impoundments to control volume
 - Recirculation with tanks or concrete basins
 - Dewatering bins (HYDROBIN®)
 - Remote drag conveyors (RSC2™)
 - Dewatering basins

Precipitation vs. Evaporation



<http://mi.water.usgs.gov/projects/WaterSmart/background.html>

Bottom Ash Transport Systems



Source: Steam Electric Survey, [ERG, 2015a].

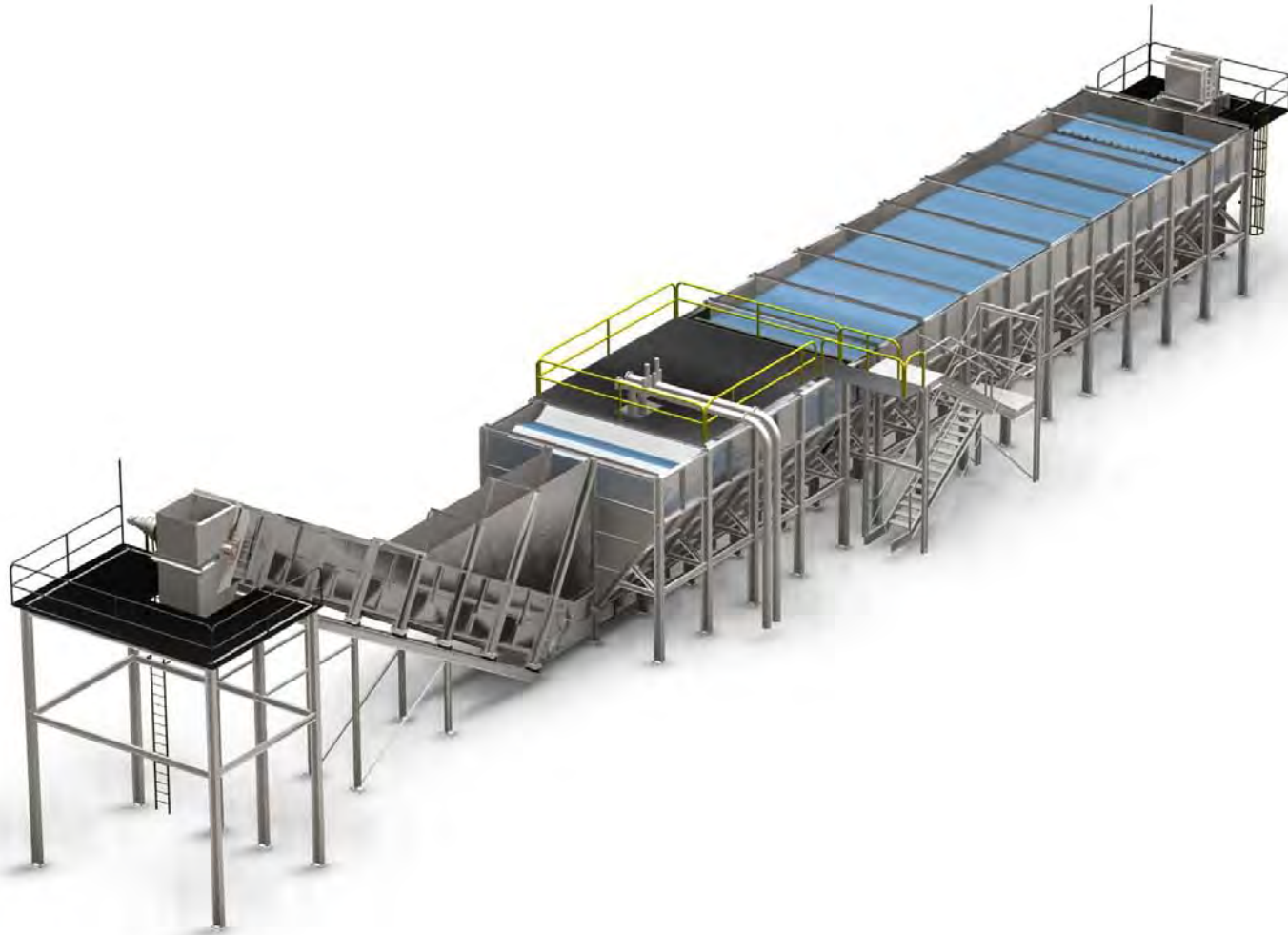
Advantages of Closing Loop on Wet Sluice System

- ▶ Ash hoppers, grinders, sometimes pumps can remain in place
- ▶ No outage requirements
- ▶ No boiler area congestion issues
- ▶ Truck traffic and material handling can be located remotely
- ▶ Dewatering and storage facility can serve multiple boilers

HYDROBIN® System



Remote Submerged Chain Conveyor (RSC2™)



What Water Applies to ELG?

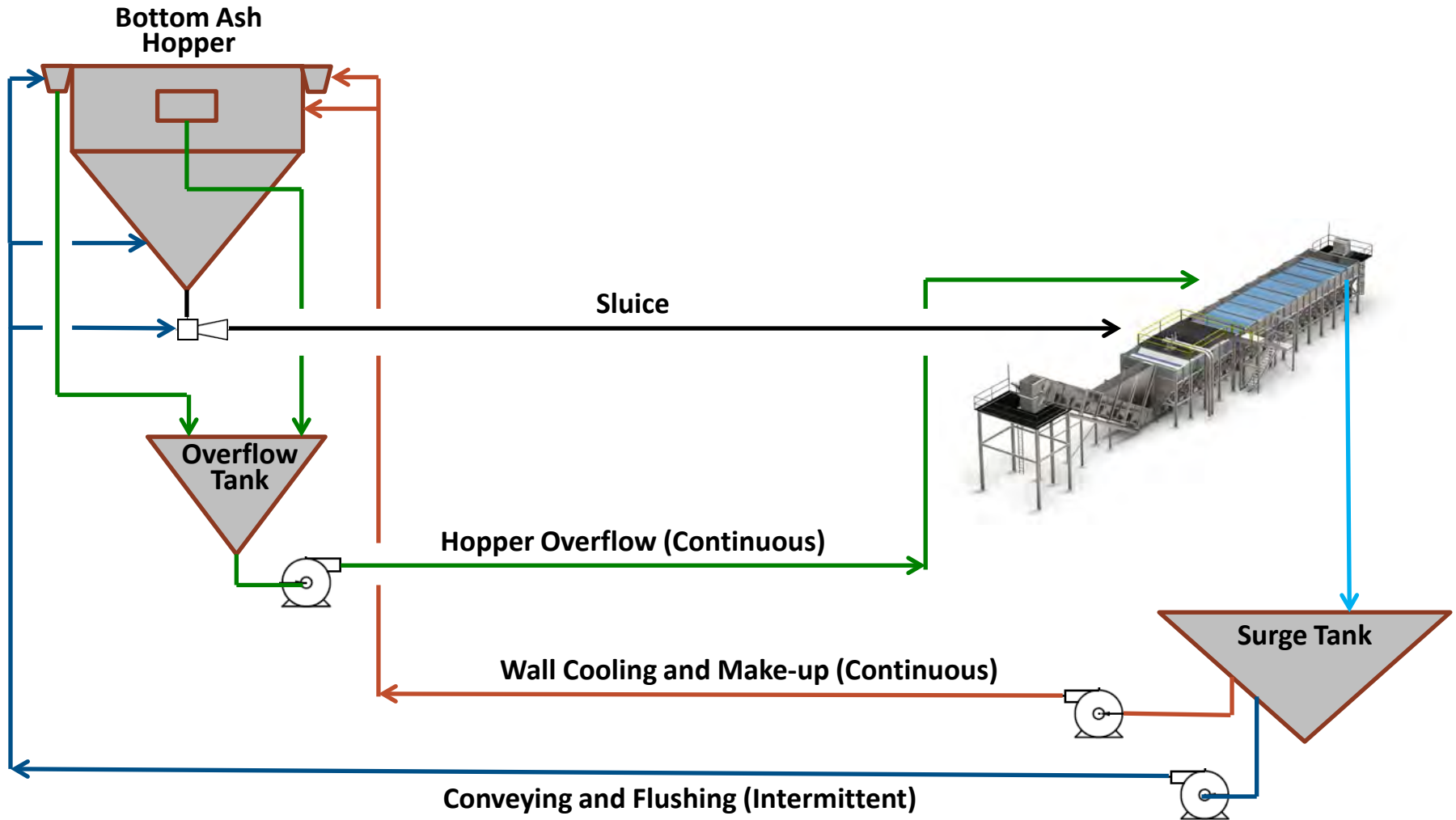
▶ Includes

- Transport water (bottom ash and economizer)
 - 1,500 – 3,500 GPM/line
- Water from draining a wet sluicing containment vessel
 - 100,000 – 500,000 Gallons

▶ Excludes

- Quench water (ash hopper service water)
 - 300 – 500 GPM/unit
 - Note quench water becomes transport water in wet sluicing systems
- Discharges from minor maintenance events
 - Valve leaks, minor line leaks, grinder or pump seal failures, etc.

Closed Loop Flow Diagram



Surge Tank

- ▶ Surge tank manages water inventory in system
- ▶ Minimum volume required for recirc pump suction
- ▶ Capacity to drain system volumes
 - HYDROBIN® tanks or RSC2™ volumes
 - Ash hopper volumes
 - Piping volumes
 - Overflow tanks

HYDROBIN[®] System with Surge Tank



RSC2™ Building Enclosures

- ▶ Covering for rain protection over dewatered ash piles
- ▶ Equipment is designed for outdoor service
- ▶ Considerations for conveyor enclosure
 - Freeze protection
 - Does it increase likelihood of good maintenance practices at your site?
 - Overhead lifting access
 - Cost
 - Number of conveyors, overflow water quality, and storage bunker capacity dictate size of building
 - Large storage bunkers under RSC2™ spreads out conveyor-to-conveyor spacing and makes dewatering incline long

RSC2™ Building Enclosure



Dewatered Ash Pile



System Water Balance

- ▶ Water losses
 - Ash hopper evaporation (5 – 15 GPM/unit)
 - Retained moisture in dewatered ash (2 – 20 GPM/unit)
 - Hopper leakage?
 - Natural evaporation (<1 GPM yearly average)
- ▶ Water additions
 - Seal water for pumps (20 – 100 GPM total for all pumps in system)
 - Rain if not in building (<1 GPM yearly average)
- ▶ Need to ensure net loss of water in system
 - Helps control water chemistry
 - Consider mechanical pump seals
 - Ways to get rid of water from system?

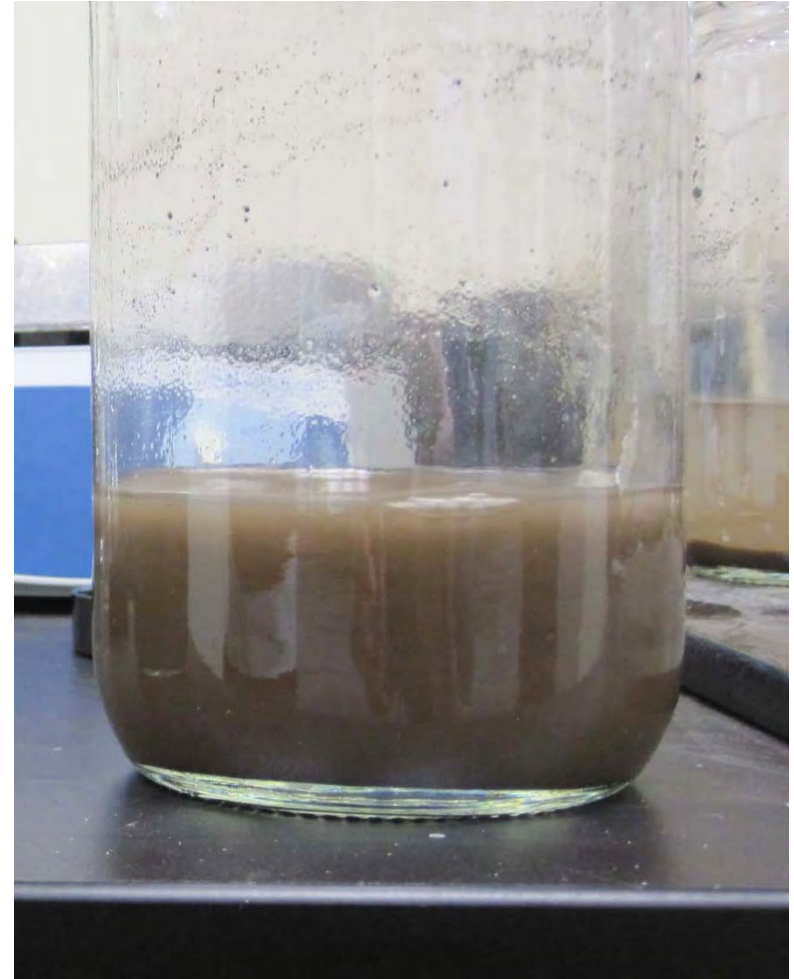
Plant-Wide Water Management

- ▶ Ways to get rid of ash transport water
 - Makeup to FGD
 - Lone exception to ELG anti-circumvention provision
 - Consider water quality requirements
 - Fly ash conditioning

- ▶ Other ways to use closed loop ash system
 - Metal Cleaning Wastes with significant solids content
 - Boiler wash
 - Air pre-heater wash
 - Precipitator wash
 - ELG would not allow ash transport water to go to low volume waste pond after being used in another process

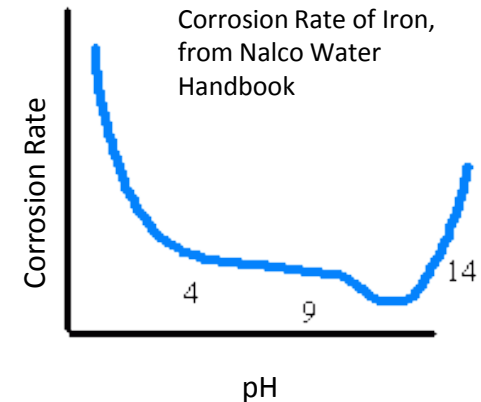
Water Quality in Closed Loop

- ▶ Corrosion
- ▶ Scale formation
- ▶ Fouling
- ▶ Total suspended solids (TSS)



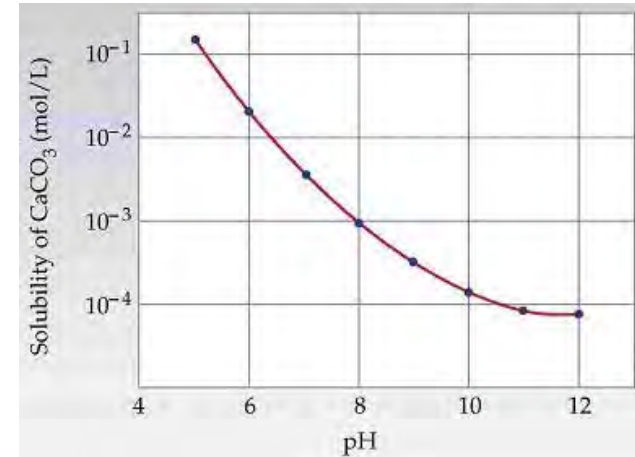
Water Quality – Corrosion

- ▶ High sulfur coals can produce low pH (4 – 6)
- ▶ Low sulfur coals tend to produce high pH (10 – 12)
- ▶ Largely depends on how much makeup water is added to system
- ▶ Wet/dry interfaces most susceptible
 - Overflow weirs and trough
 - Dewatering incline
- ▶ Acid or caustic injection can be used



Water Quality – Scale Formation

- ▶ Common with sub-bituminous coals
 - Usually calcium carbonate or aluminum hydroxide
- ▶ Factors affecting scale formation
 - Dissolved solids concentration
 - Concentration increases with water recirculation
 - pH
 - CaCO₃ precipitates at high pH
 - Sub-bituminous slurry samples pH = 10 – 12
 - Temperature
 - CaCO₃ solubility decreases at higher temperature (more dissolved solids precipitate as scale)
 - Closed loop systems will run a little higher water temperature (90 – 110 F)
 - Fouling due to deposition of suspended solids
 - High suspended solids increase scale potential by increasing number of nucleation sites



<http://www.ldeo.columbia.edu/~sanpisa/OceanSed%20project/class%20project/caco3phsol.JPG>

Water Quality – Scale Formation

▶ Controlling scale formation

- pH adjustment
 - Keep pH below critical value for precipitation
 - May not be successful long term due to continual buildup of dissolved solids
- Scale inhibitors
 - Polymers attach to crystals to inhibit growth

Water Quality – Suspended Solids

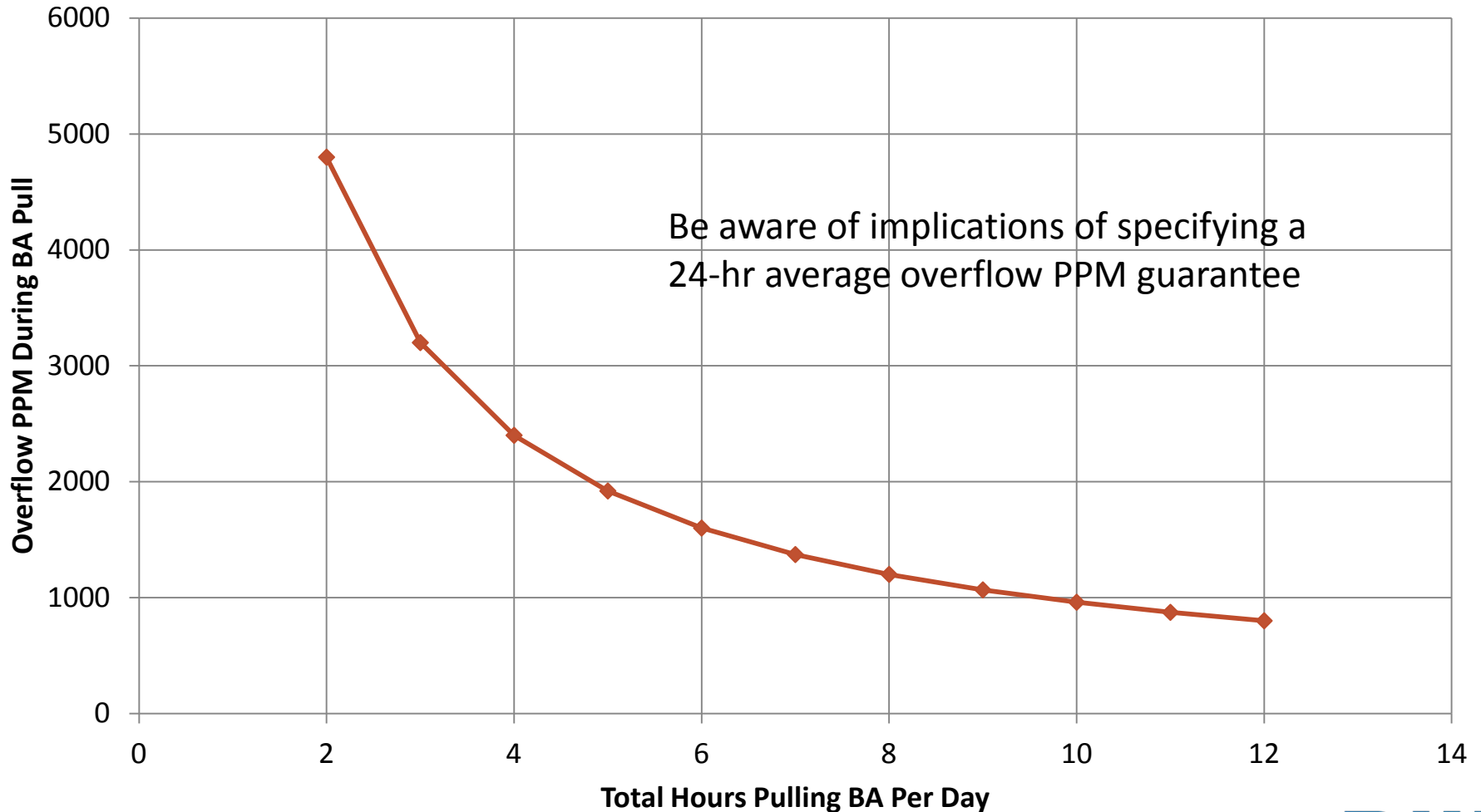
▶ Impact of overflow TSS

- Erosive wear
 - Pumps
 - Nozzles
- Sludge accumulation
 - Seal water troughs
 - Effluent basins
- Fouling
 - Pipes
 - Pump intakes



Overflow TSS – A Performance Guarantee

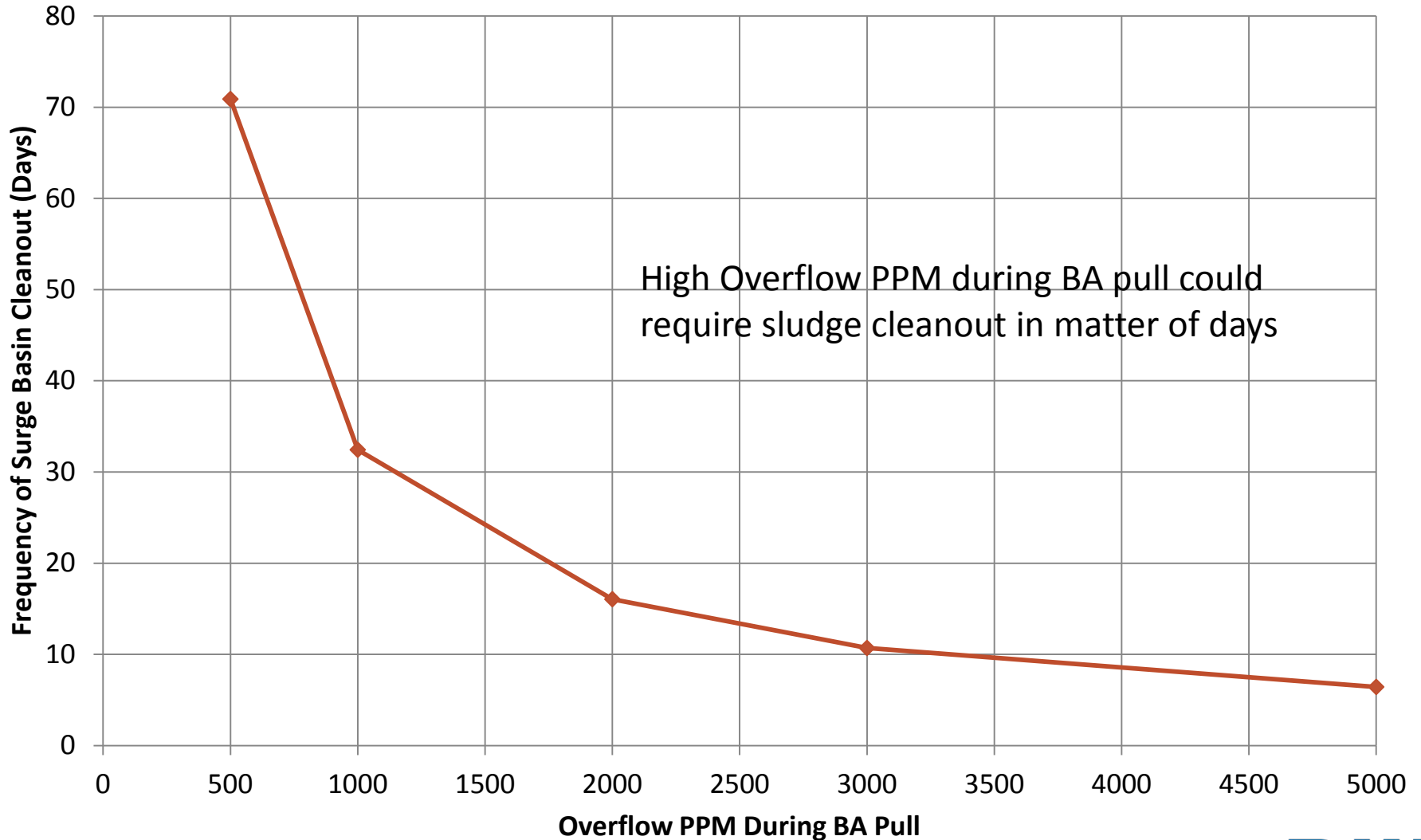
To Achieve Average Overflow of 400 PPM



What Happens to Fines in Overflow Water?

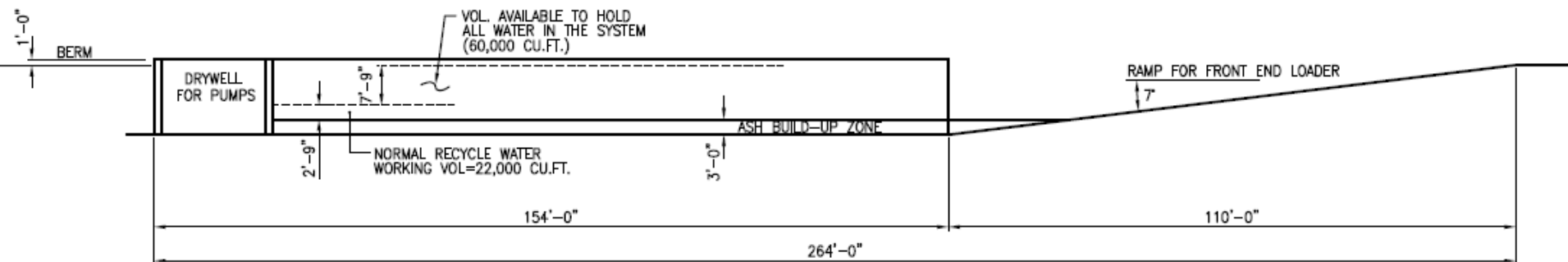
- ▶ When not pulling BA, flow rate drops significantly and fines begin to settle in effluent basin/surge tank
- ▶ >90% of fines will settle out in 3 hours under these conditions
- ▶ Sludge accumulation can be hundreds of cubic feet per day
- ▶ Agitation to keep solids in suspension will require large amounts of energy for the large volumes in these basins

Sludge Accumulation



Surge Volume Clean-out

- ▶ Elevated steel tank
 - Provides automated clean-out
 - Sludge pumps can be high maintenance
 - Need intermediate effluent sump for RSC2™ due to elevation
 - Some material will still settle in sump
- ▶ In-ground concrete basin
 - Periodic cleanout with excavation equipment
 - Optional sloped floor drive-in design for clean-out
 - Footprint can be large

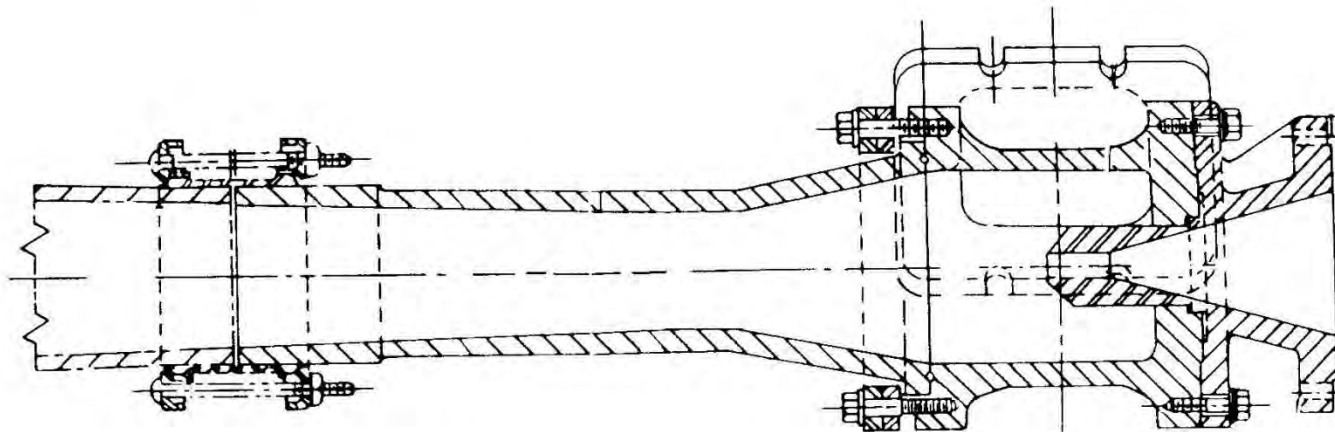


Elevated Steel Tank Clean-out



Equipment wear

- ▶ High TSS accelerates wear
 - Pumps
 - Are existing pumps rated for high TSS?
 - Nozzles
 - Degrading Hydro-Ejector performance
 - Takes longer to empty ash hopper



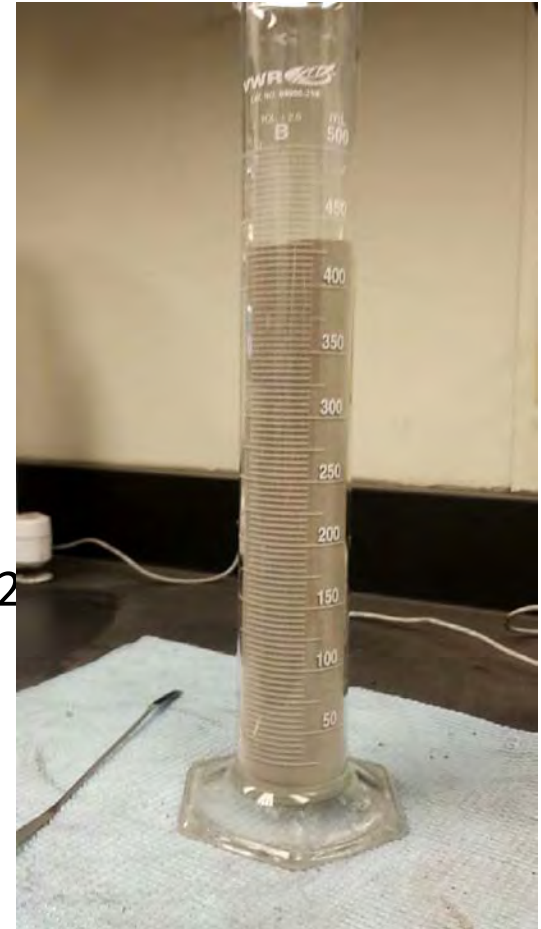
Developing a Robust System Design

- ▶ A well-designed system requires audit of existing system
 - Flow rates
 - Current operational practices
 - Water chemistry
 - Ash material properties

Ash Material Properties

- ▶ Bulk density
 - Affects volumetric accumulation
 - Affects transport rates
- ▶ Compacted density
 - Affects structural calculations
- ▶ Particle density
 - Affects particle settling
- ▶ Cohesive strength
 - Affects chain loading and pull requirements for RSC2
- ▶ Particle size distribution
 - Affects particle settling
 - Affects dewatering

By far the biggest impact
on equipment size



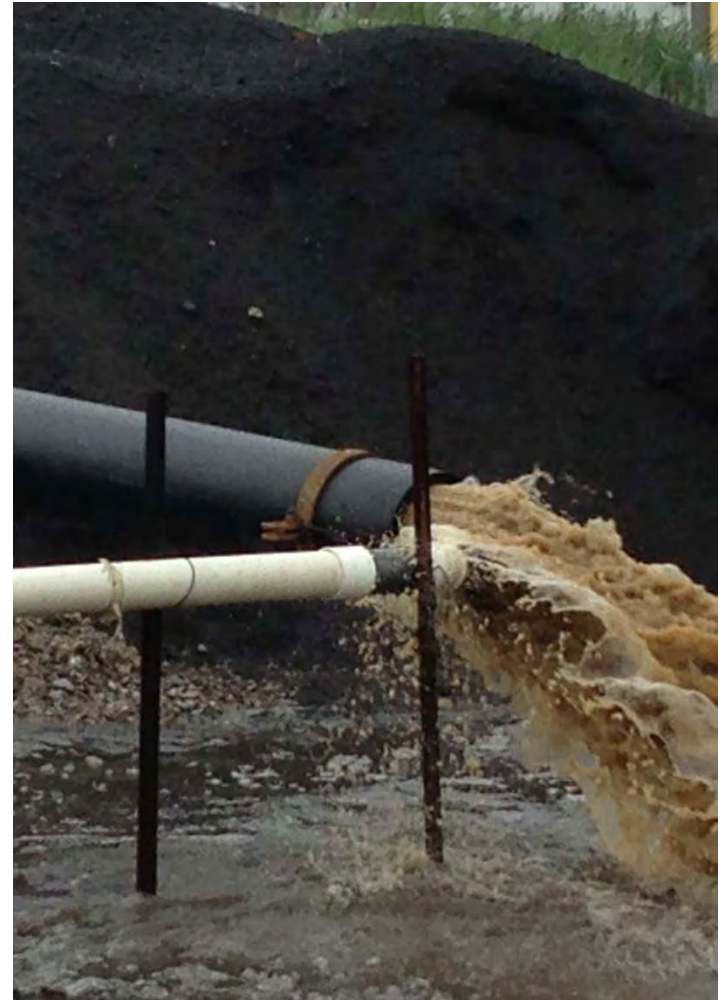
Sensitivity to Particle Size

- ▶ Fine vs. coarse material can cause:
 - 2 – 3x more chain pull force
 - 3 – 5x surface area for equivalent overflow TSS
 - 50% higher dewatered moisture content



Sampling for TSS Control

- ▶ To get samples with representative particle size distribution, the BA slurry must be sampled
 - Scooping solids from a pond will not provide this
- ▶ Slurry samples have more fines than pond samples
- ▶ Bottom ash is finer than most people think



Sampling for Water Chemistry Control

- ▶ Water chemistry may be different in a closed loop system than existing wet sluice system
- ▶ Dissolved solids content may cycle up
 - New ash always being added to water
 - Some water does leave system with 'dewatered' ash and makeup water will be required
 - What is source of makeup water? What does it have in it?
- ▶ Various streams can be sampled from existing sources
 - Sluice water samples
 - Quench water samples
 - Existing water source to be used as makeup to future system
- ▶ Models can provide estimates of water chemistry in future closed loop system

Summary

- ▶ CCR rule will force closure of some impoundments ahead of ELG compliance window
- ▶ ELG will eventually put an end to sluicing ash to impoundments for most sites
- ▶ Conversions of wet sluice systems to closed loop will be most preferred approach

Summary Continued

- ▶ Water balance becomes important since ELG also applies to drained water
 - A careful review of existing and new streams is necessary
 - Water addition is easy. Getting rid of water is more difficult.
- ▶ Water quality becomes a bigger concern in a contained system with more mechanical equipment
 - Prepare for water chemistry control
 - Consider impact of high overflow TSS and effect on O&M costs
- ▶ Develop a robust design by doing front-end homework
 - Audit existing system for operational practices, flow rates, ash properties, etc.

Thank You

