REINHOLD ENVIRONMENTAL Ltd.

2016 NOx-Combustion-CCR Round Table Presentation

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

Overview of New Wastewater/ CCR Regs

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Agenda

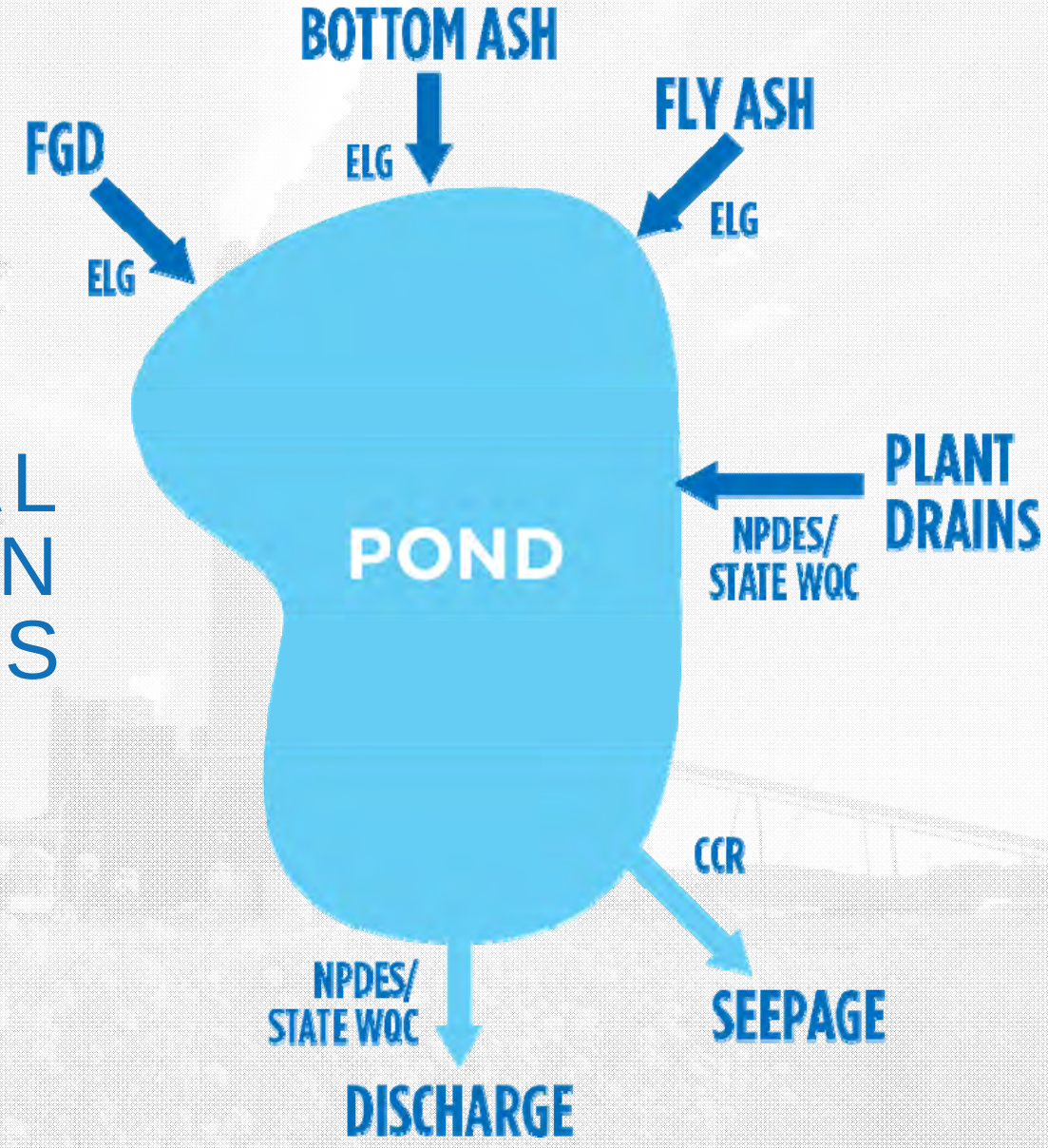
CCR and ELG Rule Backgrounds

Bottom Ash Systems

FGD Wastewater Treatment Technologies

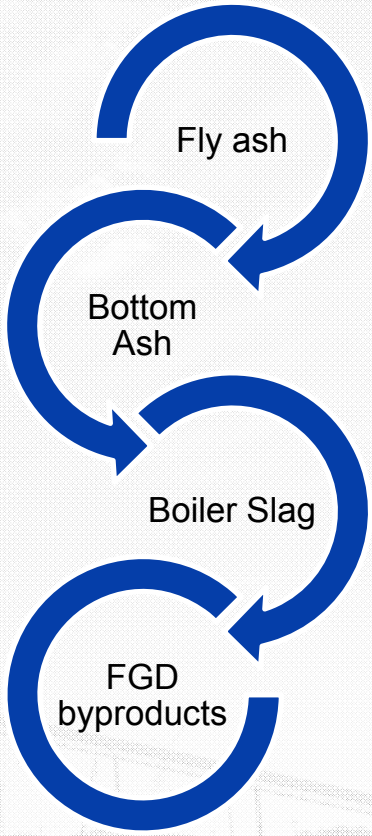
Case Studies

COAL COMBUSTION RESIDUALS



CCR Rule Overview

- Rule Effective as of October 19, 2015
- Federal Minimum Standard – **States can be more restrictive**
- CCR is defined as fly and bottom ash, boiler slag or FGD materials
- Beneficial uses defined/unencapsulated uses discouraged
- Publish documents on CCR website
- Citizen Suit Authority



CCR Rule Overview

- Rule does not apply to:
  - Landfills no longer receiving CCR by effective date
  - “Closed” CCR impoundments
  - Inactive ponds that are closed by April 2018
  - CCR units at facilities no longer generating electricity by the effective date
  - Non-utility operations (manufacturing, universities, hospitals, etc.)
  - CCR beneficially used, placed in mines, or disposed in municipal landfills
  - Fuel blends < 50% coal

Required Demonstrations & Recordkeeping

Requirement	New CCR Landfills	Existing CCR Landfills	New CCR Ponds	Existing CCR Ponds	Inactive CCR Ponds	Initial Date Required for Facilities[1]
Locational Restrictions[2]						
Placement Above the Uppermost Aquifer	✓		✓	✓		OCT. 2018
Wetlands	✓		✓	✓		
Seismic Impact Zones	✓		✓	✓		
Fault Areas	✓		✓	✓		
Unstable Areas	✓	✓	✓	✓		
Design Requirements						
Composite Liner	✓		✓	✓		OCT. 2016
Leachate Collection & Removal System	✓					Prior to Initial Receipt
Groundwater Monitoring	✓	✓	✓	✓		OCT. 2017

[1] Date for new facilities generally required before initial receipt of CCR materials or within 6 months of sampling initiation.
[2] If location, groundwater or safety criteria not satisfied, ponds must cease receiving CCR within 6 months & begin closure process or demonstrate no other disposal alternatives.

Required Demonstrations & Recordkeeping

Requirement	New CCR Landfills	Existing CCR Landfills	New CCR Ponds	Existing CCR Ponds	Inactive CCR Ponds	Initial Date Required for Facilities[1]
Structural Integrity Criteria						
Marker			✓	✓		DEC. 2015
Hazard Potential Classification Assessments			✓	✓		OCT. 2016
Emergency Action Plan			✓	✓		APR. 2017
History of construction[3]				✓		OCT. 2016
Construction Plan[3]			✓			Prior to Initial Receipt
Structural Stability Assessments[3]			✓	✓		OCT. 2016
Safety Factor Assessments[2,3]			✓	✓		OCT. 2016
Weekly Inspections	✓	✓	✓	✓		OCT. 2015
Annual Inspections	✓	✓	✓ 3	✓ 3		JAN. 2016

[1] Date for new facilities generally required before initial receipt of CCR materials or within 6 months of sampling initiation.
[2] If location, groundwater or safety criteria not satisfied, ponds must cease receiving CCR within 6 months & begin closure process or demonstrate no other alternatives.
[3] Only required for ponds with height of 20 ft. or more: or with height of 5 ft. or more and volume > 20 acre-ft.

Required Demonstrations & Recordkeeping

Requirement	New CCR Landfills	Existing CCR Landfills	New CCR Ponds	Existing CCR Ponds	Inactive CCR Ponds[1]	Initial Date Required for Facilities[2]
Other						
Fugitive Dust Controls	✓	✓	✓	✓		OCT. 2015
Run on, Run off Controls	✓	✓				OCT. 2016
Hydrologic & Hydraulic Capacity Requirements			✓	✓		OCT. 2016
Closure Requirements	✓	✓	✓	✓	✓	OCT. 2016
Post Closure Care[3]	✓	✓	✓	✓		OCT. 2016

[1] Inactive CCR ponds do not receive CCR after Oct. 2015, still contain water/CCR after Oct. 2015 must complete closure by Apr. 2018. Intent to close and closure plan must be submitted by Dec. 2015.
[2] Date for new facilities generally required before initial receipt of CCR materials or within 6 months of sampling initiation.
[3] Does not apply to CCR ponds that have closed by removing all CCR materials and have verified groundwater not contaminated.

2016 Reporting Efforts

- January
  - Annual Inspection Results
- ASAP
  - Site Surveys
  - Compliance Strategy/ELG Impacts/Overall Schedule
  - Stability/Safety Factor Assessments Awarded
- October
  - History of Construction/Liner Documentation
  - Hazard Potential Classification
  - Results of Stability/Safety Factor Assessments
  - Inflow Design Flood Control System Plans (Ponds)
  - Run-on/Runoff Control System Plans (Landfills)
  - Closure and Post-Closure Plans
- December
  - Initial Annual Dust Control Report
- Other
  - Groundwater Sampling/Analysis (Ongoing)
  - Weekly Inspections (Ongoing)

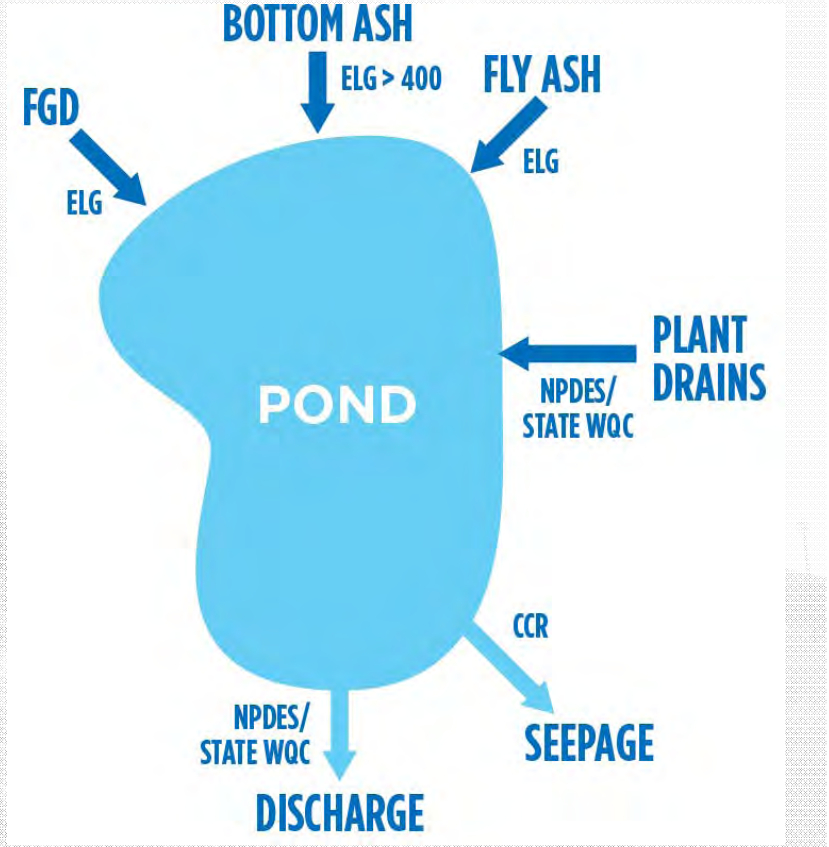
CCR Rule – Triggers for Pond Closure

- Structural Integrity Criteria/Safety Factor Assessments
  - 18 months/October 2016
- Groundwater contamination from unlined ponds
  - 30 months/October 2017 with first annual report due January 2018
- Failure to meet location restrictions
  - 42 months/October 2018
- 6 months to cease sluicing and begin closure

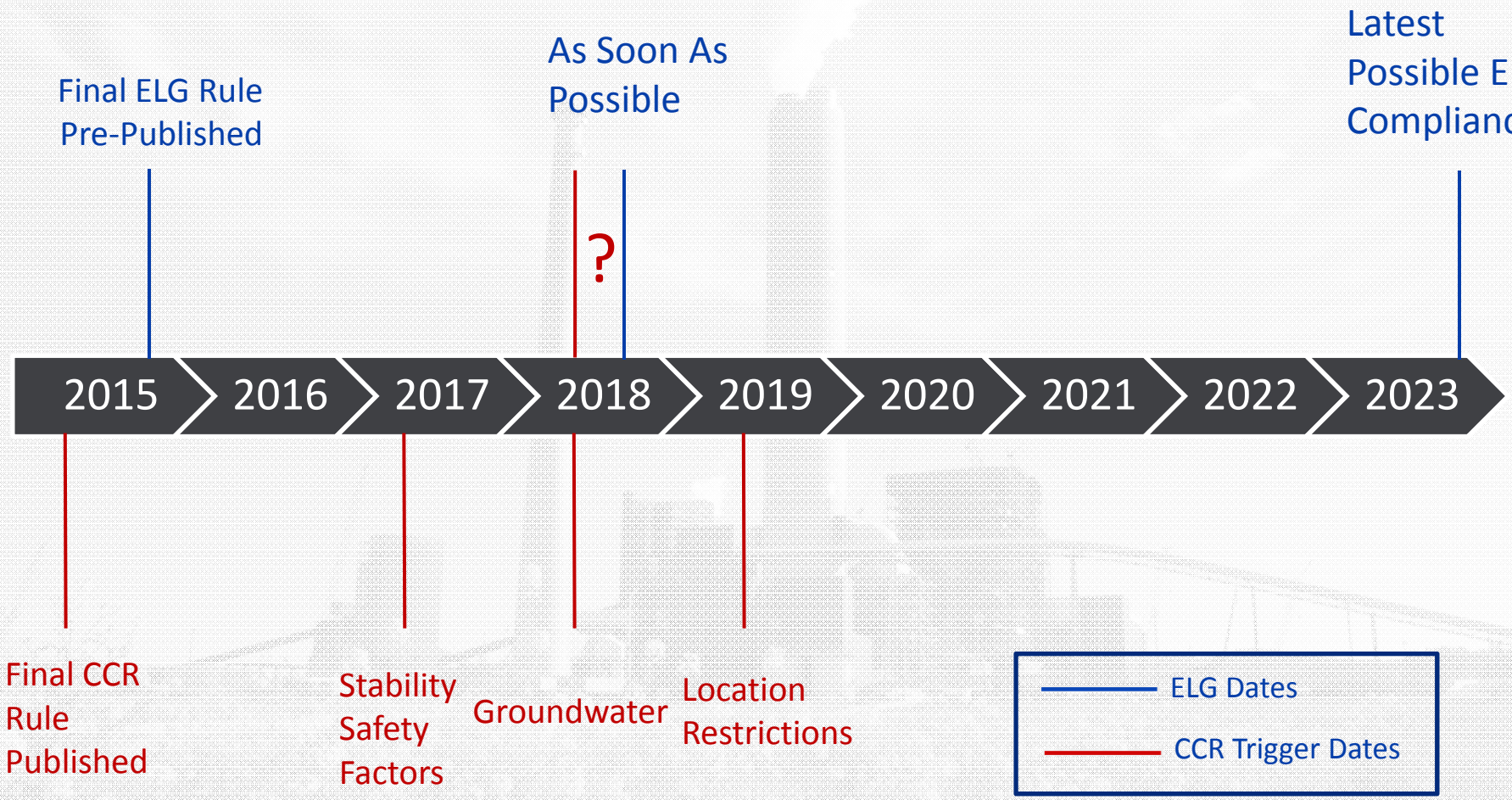
Implementing a Holistic Approach

CCR burden is bigger than it may appear

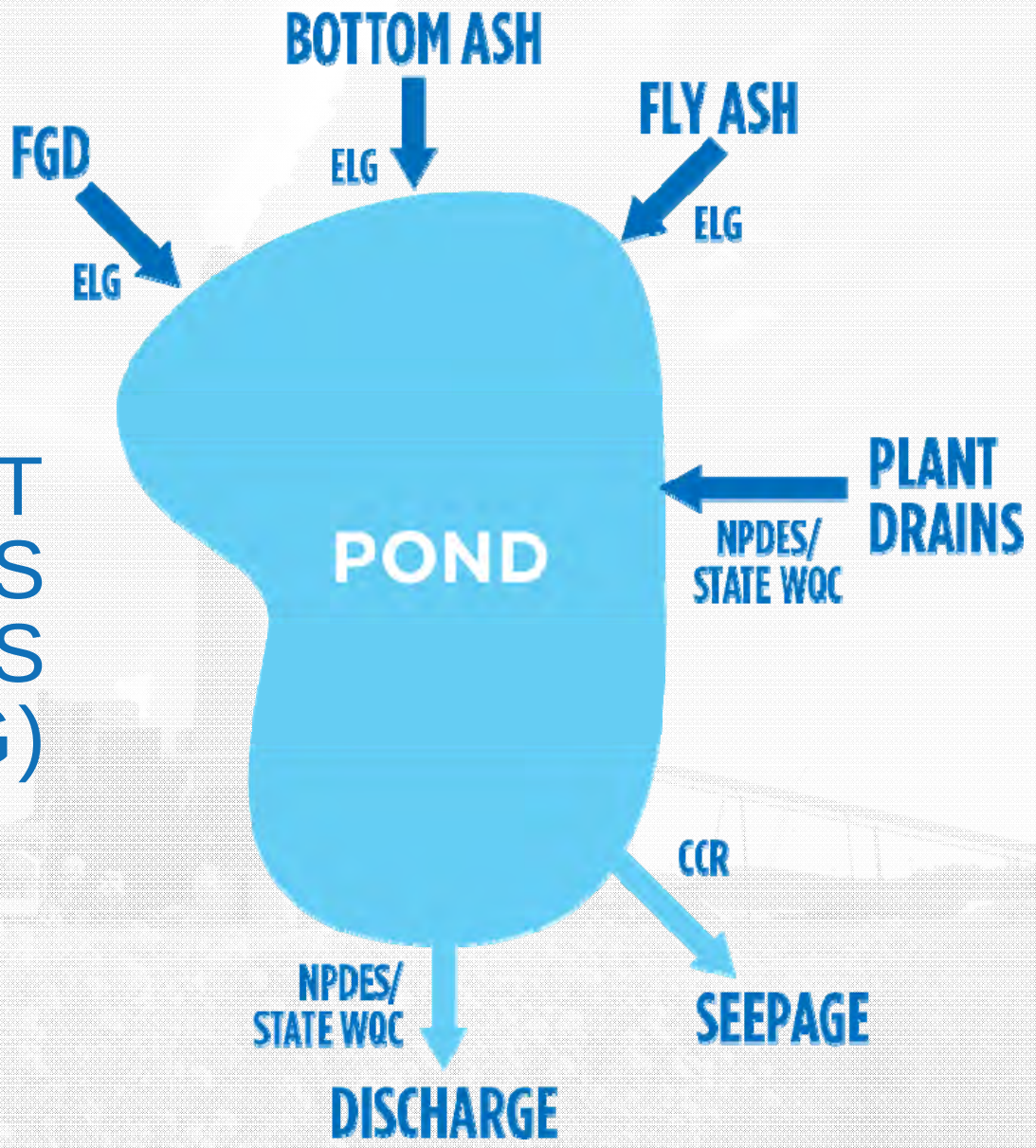
- Ponds are typically key to overall plant water balance
- Overlap between ELG/CCR & State Water Quality Criteria
- Potential Projects Involved:
  - Water Balance Optimization
  - Groundwater Monitoring/Remediation
  - Ash Handling Conversions
  - Wastewater Treatment Systems
  - New Process Ponds
  - New Landfills
  - Pond Closures



Collision with ELG Schedules

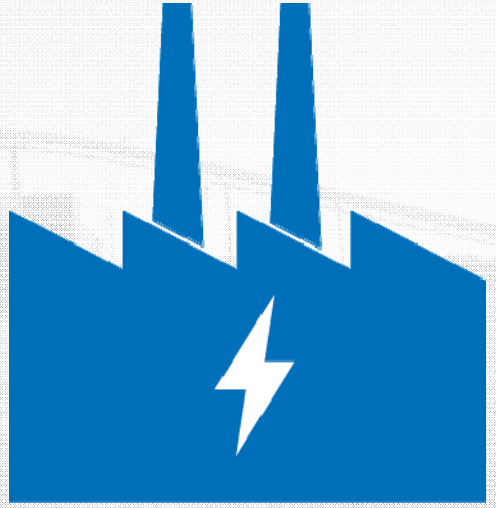


EFFLUENT LIMITATIONS GUIDELINES (ELG)



ELG Rule Applicability

- Signed September 30th, 2015
  - Effective date:
    - **60 days after Federal Register publication**
- Applies to:
  - *"…generation of **electricity** is the predominant **source of revenue** or … **reason for operation**"*
  - Targets:
    - Coal-fired generation
    - Gasification
  - 50 MW and larger



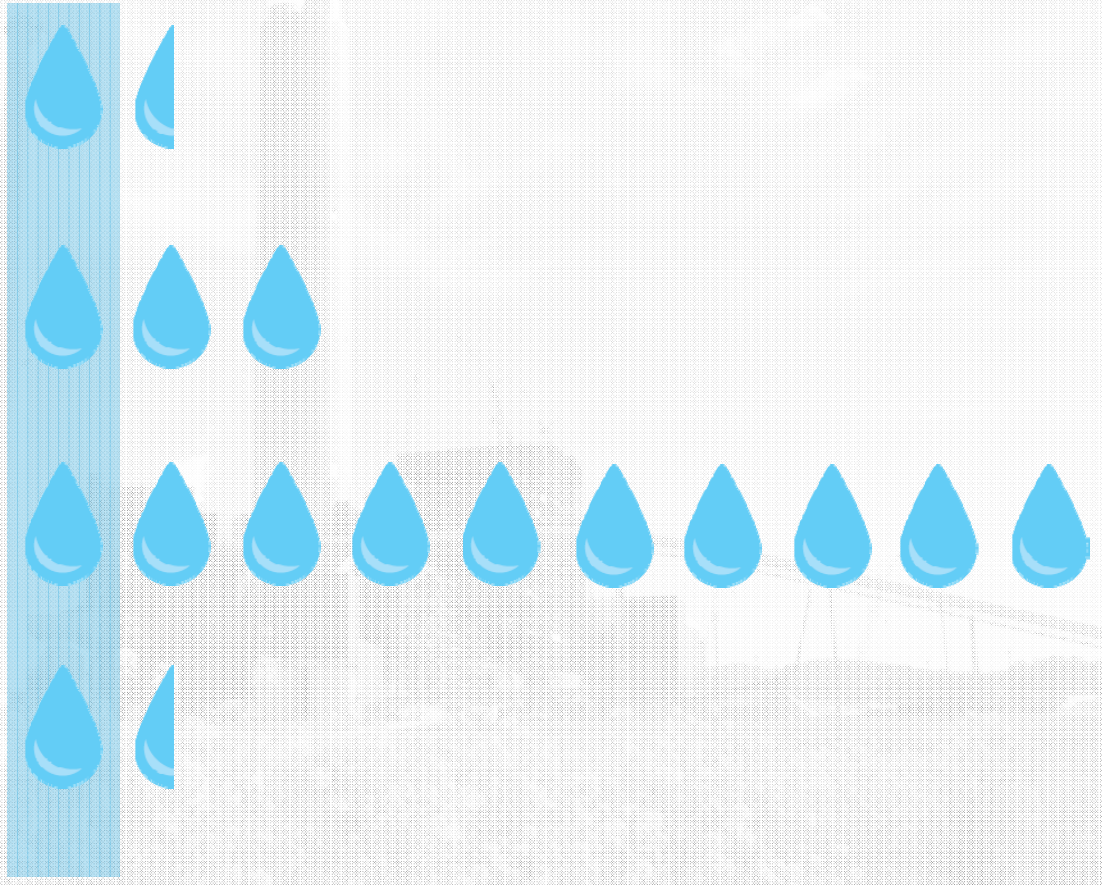
BAT Identified by EPA

Waste Streams	Technology Basis for Existing Plants
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 (Equal to BPT)
Non-chemical Metal Cleaning Wastes	(Reserved)

Limits for Existing FGD Wastewater Sources

FINAL

- Arsenic
- Mercury
- Nitrates/Nitrites
- Selenium



PROPOSED

BAT – Best Available Technology

Economically Achievable

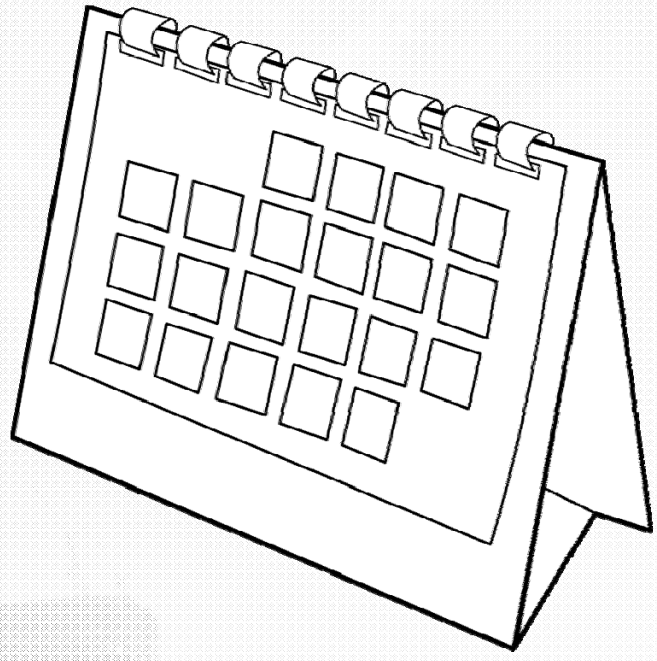
- As soon as possible

Pollutant	Maximum, any 1-day	30-day average
Arsenic, total	11 ug/L (ppb)	8 ug/L (ppb)
Mercury, total	788 ng/L (ppt)	356 ng/L (ppt)
Nitrate/nitrite, as N	17.0 mg/L (ppm)	4.4 mg/L (ppm)
Selenium, total	23 ug/L (ppb)	12 ug/L (ppb)

- In the meantime, BPT applies:

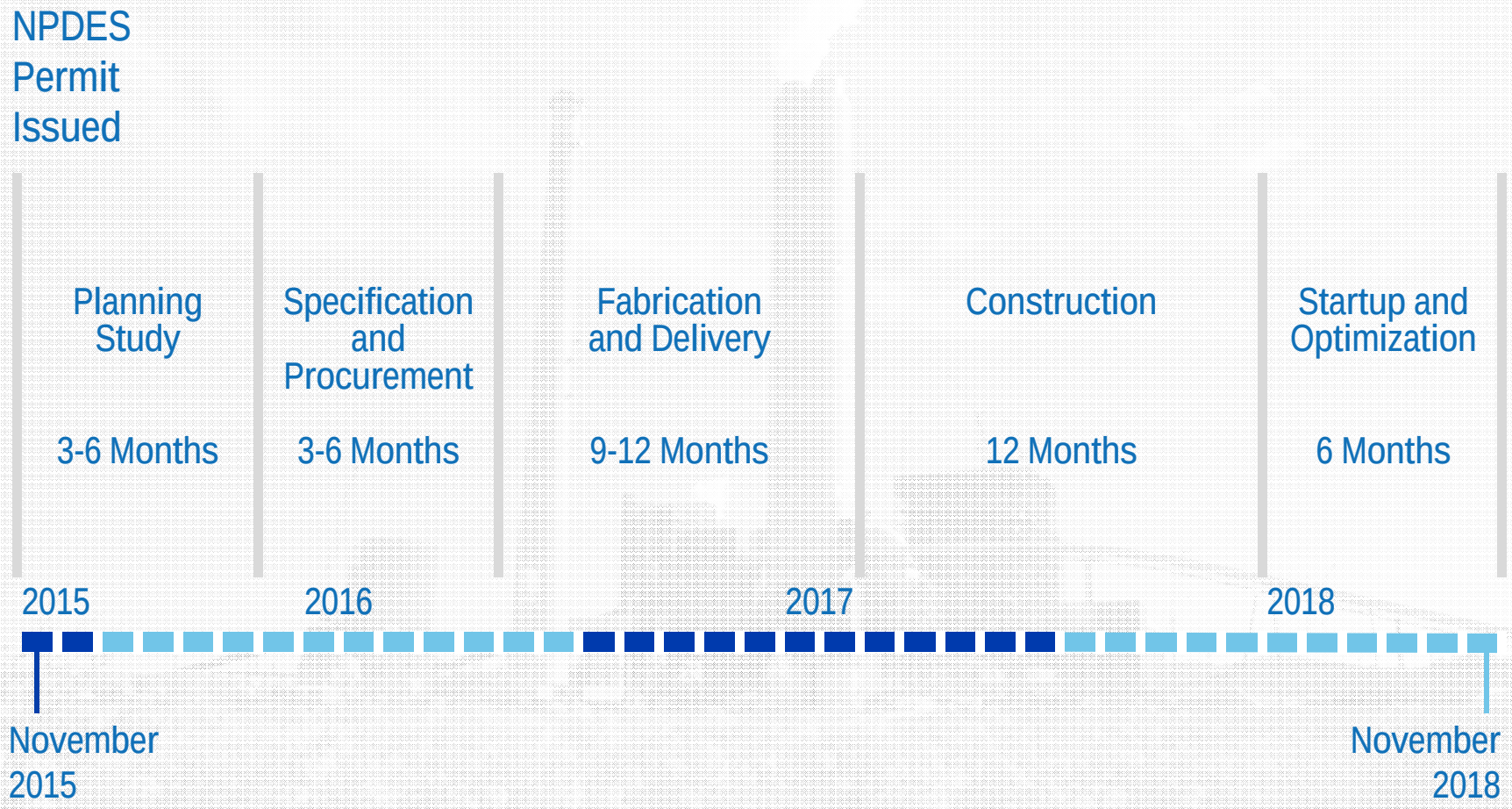
Pollutant	Maximum, any 1-day	30-day average
Oil and grease	20 mg/L (ppm)	15 mg/L (ppm)
Total suspended solids (TSS)	100 mg/L (ppm)	30 mg/L (ppm)

Federal Compliance Schedule



- ELG earliest compliance:
  - "As soon as possible"
  - Starting November 1st, 2018
- Federal compliance backstop:
  - ***Not later than*** December 31st, 2023
- Through NPDES permit system:
  - Permit application must justify compliance schedule
  - Compliance schedule issued with permit
  - Legacy wastewater not included (generated before compliance date)

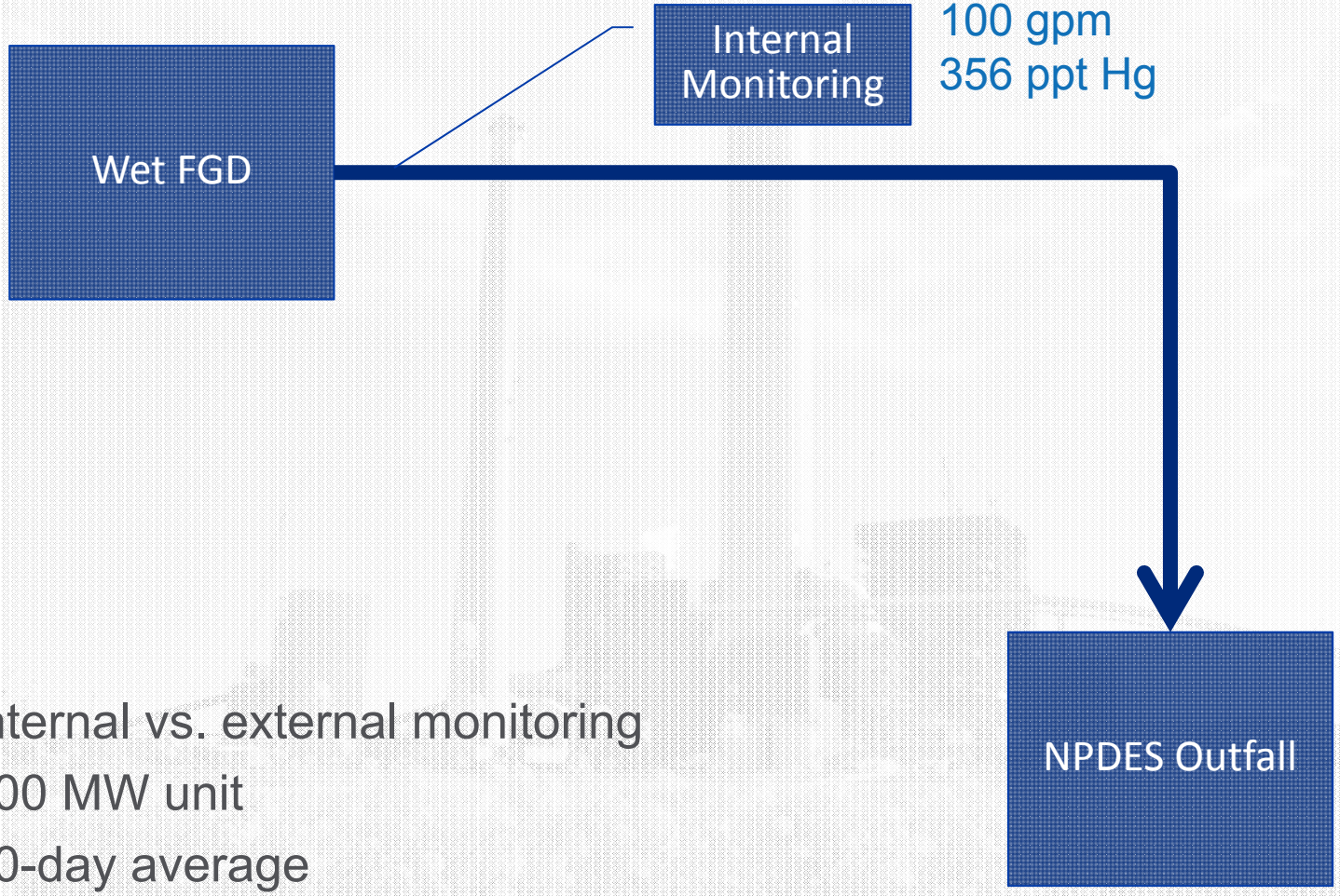
Schedule for Implementation



Other Considerations

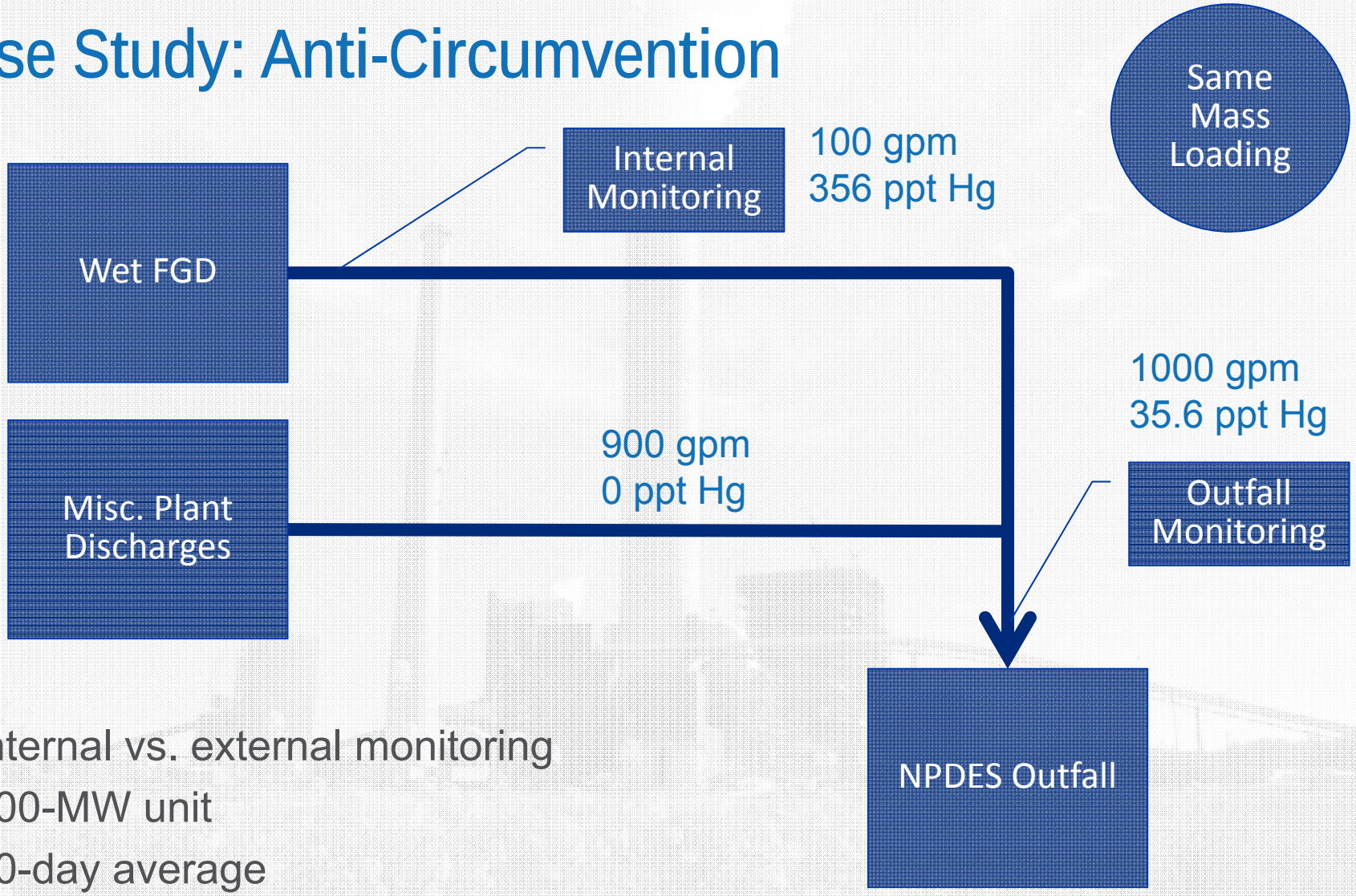
- Existing installed BAT technologies likely require upgrades
- Discharge of FGD wastewater through POTW or trucking offsite
  - Compliance still required
  - Ash transport water used as scrubber makeup
- Non-chemical metal cleaning wastewater
  - “Reserved” status
  - Revisions likely in future

Case Study: Anti-Circumvention



- Internal vs. external monitoring
- 600 MW unit
- 30-day average

Case Study: Anti-Circumvention

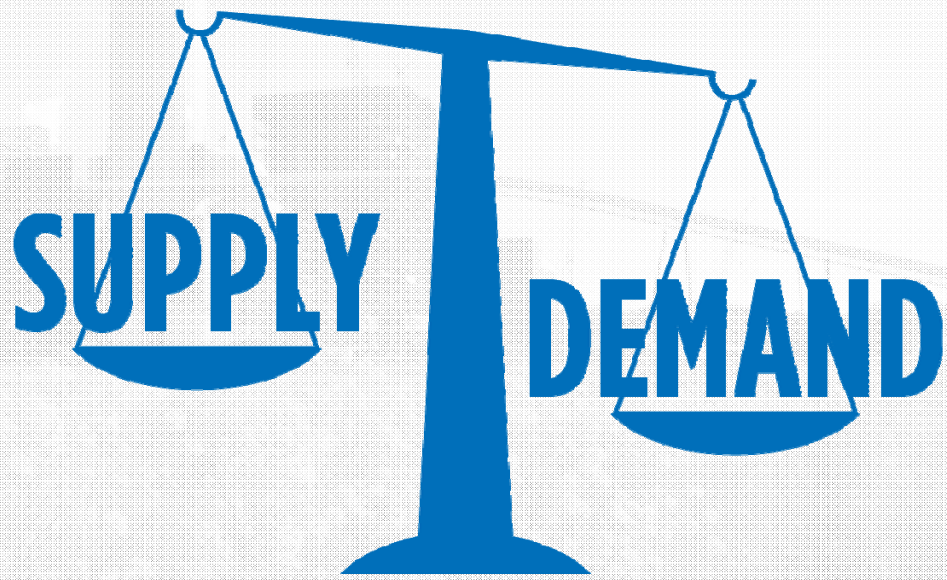


- Internal vs. external monitoring
- 600-MW unit
- 30-day average

COMPLIANCE TECHNOLOGIES
BOTTOM ASH

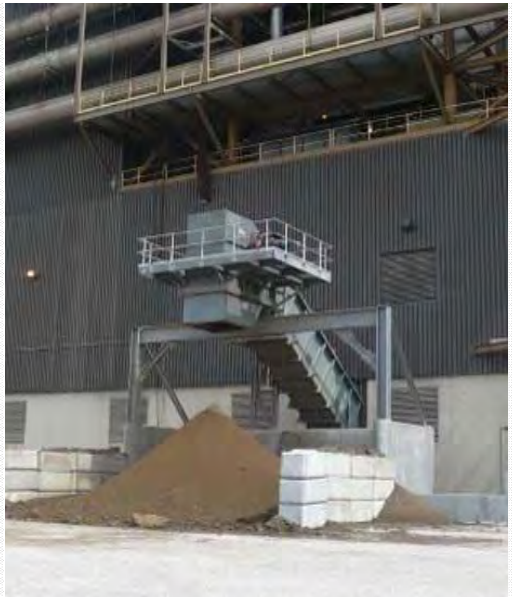
Bottom Ash Conversions - Market Update

- Future equipment lead times continue to be a concern
  - Currently 12-16 months
- Few orders have been placed
- One large project is close to award
  - 20 conveyors to be installed by spring 2018



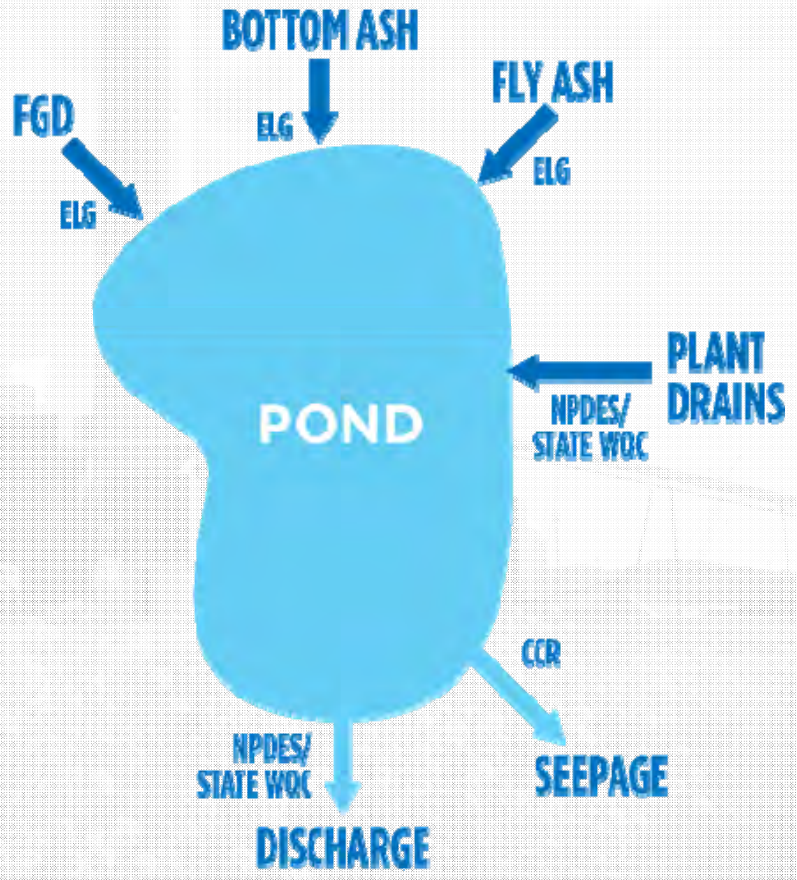
Ash Transport Water

- Transport water: water that has direct contact with the ash and is used to convey the material
- ***Not:***
  - Low volume and short duration leaks
  - Water in an underboiler drag chain conveyor
  - Dry fly ash with wet ejector system is NOT transport water
    - If CCR closes your pond, going to closed loop may present water chemistry concerns



Ash Transport Water

- Blowdown stream to FGD
- Closed loop water chemistry concerns
  - Coal additives
  - Scaling
  - Corrosion
  - pH



Case Study – Ash Handling

- 400 MW
- Cyclone boiler, no scrubber
- Existing bottom ash system
  - Open loop slag basin
  - Stormwater and plant drains go to slag basin
- Required changes
  - Convert to closed loop bottom ash system

Case Study – Bottom Ash Handling

- Bottom ash
  - Option 1 – Convert to mechanical system
    - Remote or local drag chain conveyor
    - Remove all CCR from slag pond
    - Concerns
      - Closed loop (no scrubber)
  - Option 2 – Modify slag pond
    - Convert to closed loop system
    - Segregate stormwater and plant drains
    - Concerns
      - Closed loop (no scrubber)
      - Water balance

COMPLIANCE TECHNOLOGIES
FGD WASTEWATER

Potential Technologies for Compliance

Incentives

- Volunteer to meet NSPS

Waste Streams	Pollutant	Daily Maximum Limitation	Monthly Average Limitation
Voluntary Incentives Program for FGD Wastewater (BAT only)	Arsenic (ug/L)	4	---
	Mercury (ng/L)	39	24
	Selenium (ug/L)	5	---
	TDS (mg/L)	50	24

- Install thermal evaporation technology
- Compliance date is December 31st, 2023
  - TDS of 50 mg/L
    - Discharge?

FGD Case Study

600 gpm FGD Wastewater Conversion Study

- Two units, total 900 MW FGD wastewater
- Series of ponds including ash, coal pile runoff, landfill runoff, polishing lagoons
- All wastewater including FGD to pond system
- Alternatives considered:
  - Thermal ZLD
  - Phys-chem bio

Case Study: Flow vs. Technology Selection

- 500 MW unit with wet FGD
- Blowdown 60-500 gpm
- 2018-2032 NPV of multiple technologies
  - Physical/chemical plus biological 2018
  - Thermal evaporation 2023
  - Spray dryer absorber 2023
  - Bypass evaporator (around APH) 2023
- Assumptions
  - Crystallizers necessary for higher flow rate thermal systems
  - All costs are capitalized in the first year of operation (2018 or 2023)
  - NPV includes 9 or 14 years of operation (2023 or 2018 startup, respectively)

Key Technology Selection Factors

	Phys-Chem Bio	Thermal	SDA	Bypass Evaporator
Capital Cost	$$	$$$	$$$$	$$
Work Offline	Yes	Yes	No	No
Defer Capital	No	Yes	Yes	Yes
Guarantees/ Compliance	★★	★★★	★★	★★

SUMMARY

Unintended Consequences and Other Factors to Consider with CCR & ELG Rule Implementation

- Permitting
  - Possible BACT impact
  - Air dispersion modeling
- Other regulations
  - Clean Power Plan (CPP)
  - Coal Combustion Residuals (CCR)
- CWA Section 303(c), 304(b),(m) (future ELG changes)
- The non-FGD Wastewater Impacts
  - Bottom Ash Transport Water was an Effective Dilution Technique
  - Ponds out-of-service => Concern at Discharge
    - TSS
    - Nutrients
    - Heavy Metals

Summary

- Compliance Nov. 1, 2018-Dec. 31, 2023
- CCR dates may impact ELGs
- Typical project 2-3 years (start now)
- Tailored solutions save time and money
- Supply vs. demand imbalance
- More options at lower FGD blowdown (optimize first)
- Many factors may impact decision
  - Cost
  - CCR dates
  - CPP
  - BACT
  - Public Service Commission – Rate Recovery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